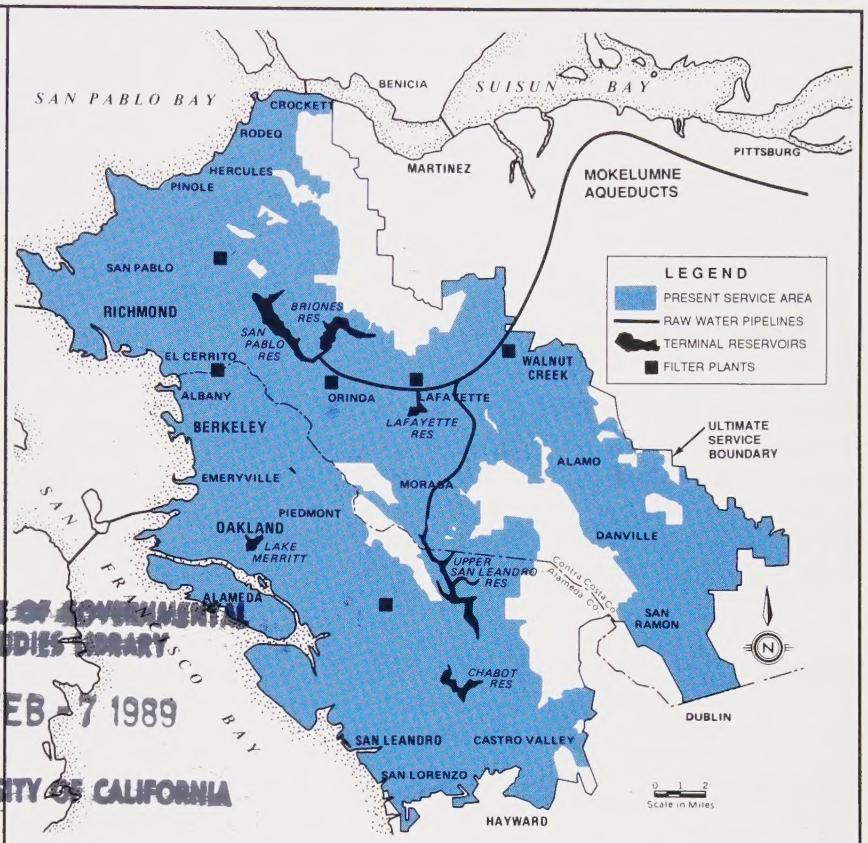
EBMUD

SUMMARY

JANUARY 1989

KEY ISSUES AFFECTING WATER SUPPLY:

- SECURITY
- SHORTAGE
- SAFETY AND HEALTH



PURPOSE

The East Bay Municipal Utility District for more than 58 years has provided a dependable supply of high quality water to meet the needs of the growing population in the East Bay service area. The water supply has been available even in times of drought and crisis---although there was drought rationing in 1977, and again in 1988, and a close call in 1980 when flood waters threatened the three aqueduct pipelines in the Delta.

The District is developing a Water Supply Management Program to identify the actions and projects necessary to continue to provide a dependable water supply for meeting the needs of the cities, communities, and people it serves.

This Summary covers the draft of the Final Environmental Impact Report and Technical Report prepared by staff and submitted to the EBMUD Board of Directors for its consideration. The continuing public review process includes a public hearing on the proposed program before any actions and projects are adopted (see back page).

INSIDE THIS SUMMARY:

INTRODUCTION

Water Supply Problems

EBMUD's water supply system, shown in Figure 2, was originally constructed in the 1920's, with subsequent additions as the service area grew. No additions have been constructed since the mid-1960s although there has been a 20 percent growth in the number of customers and a 30 percent increase in water demand.

EBMUD is facing a series of problems: (1) an increasing risk of failure of the aqueduct pipelines from the Sierras, (2) an increasing frequency of shortage in dry periods because of a water demand that is gradually increasing despite significant reductions in water use by many customers, and (3) a need for continued vigilence to protect water quality against pollution and contamination.

Developing the Solutions

To identify the security, shortage, and safety and health needs, the District's staff with the assistance of engineering and environmental consultants (see box, back page) has conducted many technical and environmental investigations.

In developing the solutions to the problems, EBMUD staff made many assumptions about the future, considering a wide range of alternatives and developing a broad range of program costs. Staff findings have now been compiled in a final report for action by the Board of Directors.

USBR Contract - American River Supply

Among the various concepts discussed in relation to the water supply problems is the connection of the District's system to an additional source of supply. Although EBMUD has had a contract with the Bureau of Reclamation since 1970 for a supplemental supply from the American River, it has not constructed the facilities to be able to use it because of litigation. The long history of this litigation may be drawing to a close. If it is resolved in the District's favor, it may be possible to connect to this new source within the next decade. The proposed Water Supply Management Program covers needed water system improvements which can proceed with or without the American River supply, which is not an alternative under consideration for addressing the security and shortage problems.

TABLE 1. PROPOSED WATER SUPPLY MANAGEMENT PROGRAM

OBJECTIVE	PROGRAM	ACTION	COST	TIMING
SECURITY: Protect against floods and earthquakes	Water Banking with rationing limited to 25%	Construct Buckhorn Reservoir (145,000 acre-feet)	$160 million	In service by 1995
	Levee and Foundation Improvements in the Delta	Continue repair, maintenance and upgrading of levees	$8 million	Complete by 1991
		Preliminary engineering of levee reinforcement and pipeline supports	$2 million	Complete by 1995
SHORTAGE: Supply to meet water demands in dry periods	Water Banking with rationing limited to 25%	Construct Buckhorn Reservoir (145,000 acre-feet)	$160 million	In service by 1995
	Water Conservation	Implement additional measures and continue existing program	$0.8 million per year	Implement immediately
	Water Reclamation	Develop new reclamation projects and continue existing program	$17 million	Implement immediately
SAFETY AND HEALTH: Maintain high quality water	Enhance Watershed Lands of Terminal Reservoirs	Purchase additional watershed lands to the ridgelines	$20 million	Complete by 1995
	Treatment Improvement Program	Continue treatment plant modernization and improvements	$35 million	Complete by 1992

PROPOSED PROGRAM

Based on engineering and environmental investigations and studies, analyses of costs, and review of public comments received on two draft reports, EBMUD staff has concluded that the solution to the District's water supply problems is the combination of program elements and actions summarized in Table 1 as the proposed Water Supply Management Program.

Water Banking

Water banking means providing sufficient storage capacity in local terminal reservoirs to help meet demand during supply disruptions and as carryover from spring runoff for use during the high demand summer months. Additional storage would provide security of the water supply against extended outage caused by aqueduct pipeline breaks in the Delta due to an earthquake disaster, and would provide the additional supply needed during dry years and drought shortages.

Buckhorn is the best reservoir site from the standpoint of location, operation, water quality, watershed ownership and protection, cost, potential environmental effects, and opportunities for mitigation. Other program options that were considered include joining with Contra Costa Water District in its Los Vaqueros Reservoir Project, and a combination of a new aqueduct pipeline across the Delta for security and a smaller reservoir for drought shortages.

The selection of Buckhorn Reservoir at this early stage in the project should not close off EBMUD's cooperative activities with CCWD regarding Los Vaqueros Reservoir. Until the regulatory approval process is completed for Buckhorn, Los Vaqueros should continue to be an alternative. The estimated cost of participating with CCWD in its ongoing preliminary engineering and environment review process is $300,000.

Policy on Rationing

EBMUD's current policy limits rationing to 39 percent in a repeat of drought conditions like 1976-77. However, that will cause a greater hardship on customers than it did in 1977 because of the improved efficiency of water use through conservation practices in normal years. It will also increase the impact of rationing in less severe

continued on p. 4

EBMUD BOARD DECISIONS

ADOPTION OF PROGRAM

The draft of the Final EIR for the Water Supply Management Program, including the Technical Report and Comments and Responses, has been submitted to the EBMUD Board of Directors for its consideration and action. After review of the technical findings and environmental documentation and after considering the comments received at several public hearings and in letters, the Board will make a series of decisions regarding adoption of a Water Supply Management Program:

1. Has the Final EIR been prepared and completed in compliance with the California Environmental Quality Act?
2. What combination of acceptable and feasible water conservation and reclamation activities---in addition to present efforts---will provide a desirable increase in water use efficiency?
3. Is water banking with the construction of additional terminal storage the solution to the water supply problems of security and shortage and should it also provide a reduction in the level of rationing planned for drought periods?
4. If water banking is the solution, which specific reservoir project best meets that need?
5. What additional elements should be part of a comprehensive Water Supply Management Program?

FUTURE ACTIONS

Construction of any facilities approved as part of the program could require an additional sequence of actions, such as the following:

- Additional geotechnical investigation.
- Pilot testing of conservation techniques.
- Application to the Corps of Engineers for a permit under Section 404 of the Clean Water Act.
- Coordination with cities, counties, and other agencies regarding the impacts of construction and construction traffic.
- Design of the facilities and preparation of plans and specifications.
- Bidding and award of construction contracts.

Proposed Program, continued from p. 3

droughts like 1987-88. To accommodate the improved efficiency and to ease the potential hardship, the proposed program includes sufficient additional storage to permit a reduction in the limit on rationing to 25 percent as a change in policy.

Conservation and Reclamation

Water conservation means the efficient use of existing supplies. Since beginning its pioneering efforts in the early 1970s, EBMUD has had a proactive water conservation program leading the nation in water conservation education and the state in legislation. Continued emphasis on water conservation and other water-efficient measures such as reclamation and reuse is a necessary part of the proposed program. Included are the continuation of existing conservation measures, the addition of feasible measures that have the potential for being successful in achieving water savings, and implementation of additional reclamation projects.

Watershed Enhancement

The District has an obligation to protect the public health by providing the highest quality water available. Coupled with EBMUD's position that the use of water from the Sacramento-San Joaquin Delta is not acceptable from a long-term public health standpoint, the need for continued monitoring and controlling of activities affecting the Mokelumne and the terminal storage watersheds is essential. Watershed management would be improved and the effects of the new reservoir mitigated by EBMUD's purchase of watershed lands currently in other ownership and which may have a potential for development.

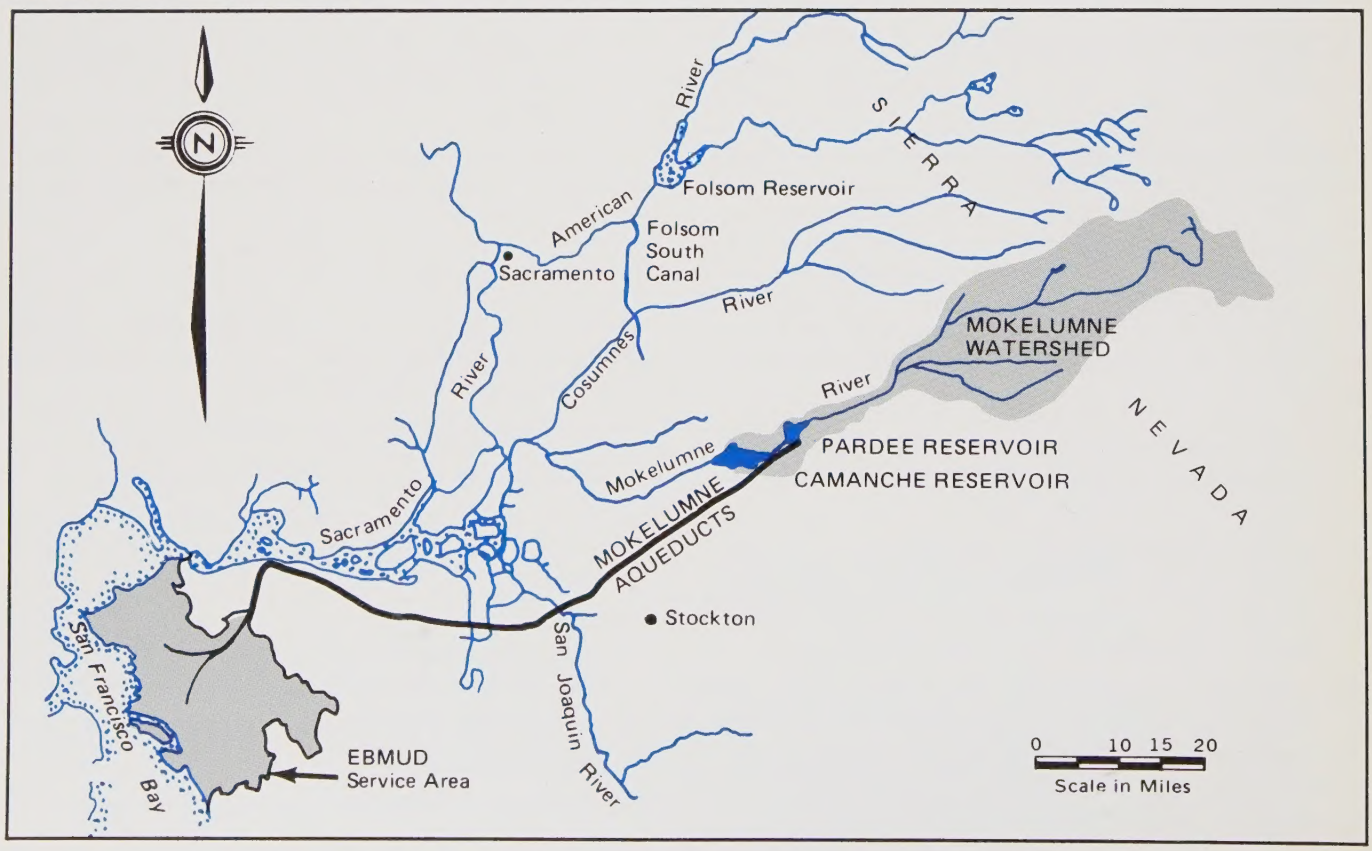
Levee and Foundation Improvements

Levee failure due to sloughing, erosion, or overtopping is a risk on the Delta islands crossed by the Mokelumne Aqueduct pipelines. Levee improvements such as minor repairs, upgrading and raising the levees at river crossings and along the alignment of the elevated pipelines would reduce the risk of failure and flooding. At the same time, preliminary engineering for levee reinforcement, modification of pipe supports, and the support system for future aqueduct replacement would be an effective part of the proposed program.

Treatment Improvement Program

Continuation of the treatment improvement program will assure that water quality will meet new drinking water standards and water treatment operations will be improved. Continued studies of advanced treatment technologies may decrease the use of chemicals and further improve water quality.

FIGURE 2. EBMUD WATER SUPPLY SYSTEM



SECURITY: PROTECT AGAINST FLOODS AND EARTHQUAKES

EBMUD's water supply system is increasingly vulnerable to natural disasters that could severely damage facilities and result in a water supply outage. The system is particularly vulnerable where the Mokelumne Aqueduct pipelines cross the Sacramento-San Joaquin Delta Region.

VULNERABILITY OF AQUEDUCTS

Levee Failures

There is a long history of levee failures in the Delta, including the region where the Mokelumne Aqueducts are located. The stake the District has in the Delta levee protection was made clear in 1980 when Lower Jones Tract flooded and the railroad embankment adjacent to the aqueducts subsequently failed, allowing floodwaters to flow into Upper Jones Tract (Figure 5). The scour caused by water rushing inland through the break began to undermine the pile supports under the elevated aqueduct pipelines.

Inundation of an island or tract is a hazard because the pipelines and supports would be submerged, and long term inundation would cause physical deterioration of the pipelines and supports and would prevent access for normal maintenance.

Earthquakes

Twelve potentially active earthquake faults which could cause damaging ground shaking have been identified within 50 miles of the Delta region (Figure 7).

A primary effect of seismic ground shaking in the Delta is the loss of strength in the water-saturated sandy soils which temporarily liquify ("liquefaction"). This serious condition affects the integrity of levee foundations and the supporting soil under and around buried pipelines, underwater river crossings, and piles under the elevated aqueducts. Another seismic effect is failure of the piles and supports under the elevated aqueducts because of inadequate structural strength to resist the earthquake forces. The extent of damage or collapse caused by these effects, which work together, depends on the level of ground shaking resulting from the earthquake. Table 3 lists the types of aqueduct failures. A low to moderate level of ground shaking caused by an earthquake on any one of 12 different faults, or a high level of ground shaking caused by an earthquake on the Antioch Fault, are the most likely events, one in 23 years and one in 83 years, respectively.

Potential Outage

Table 3 also shows the estimated repair time required until delivery of water can be restored. In the event of an extended outage, the limited supply available from the existing terminal reservoirs would have to be severely rationed and other emergency measures would be required. The

FIGURE 3. MOKELUMNE AQUEDUCTS IN THE DELTA

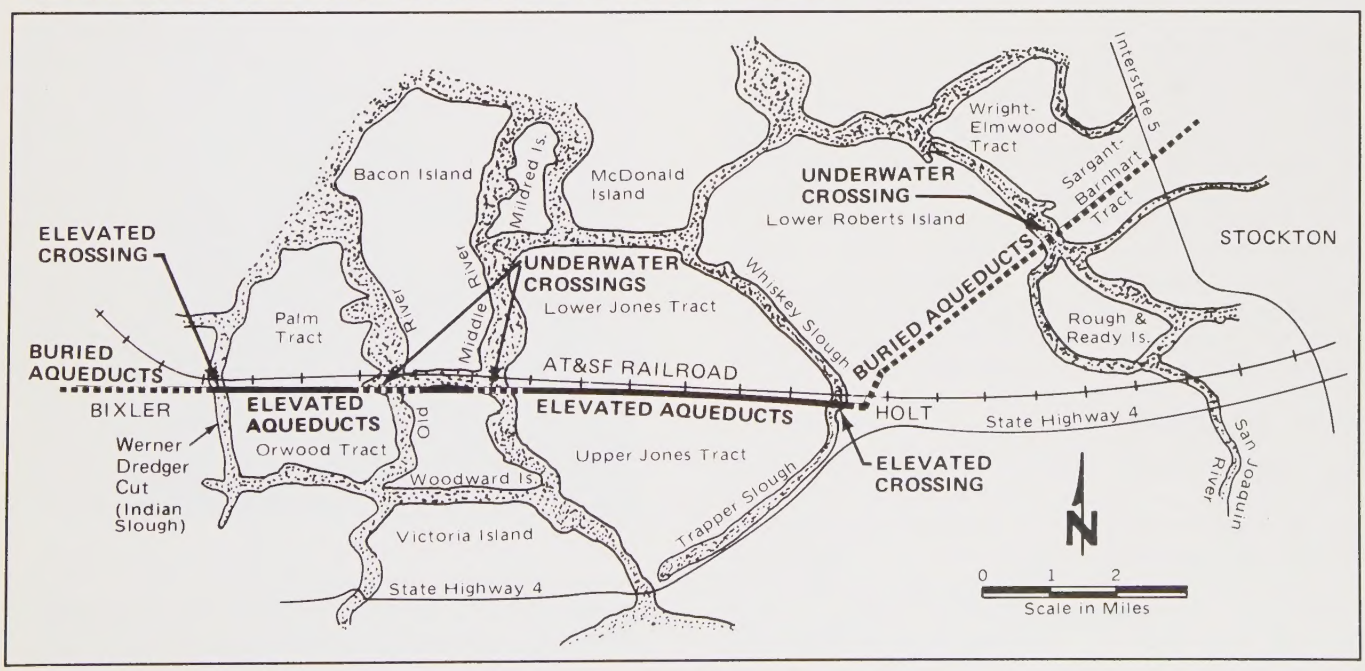
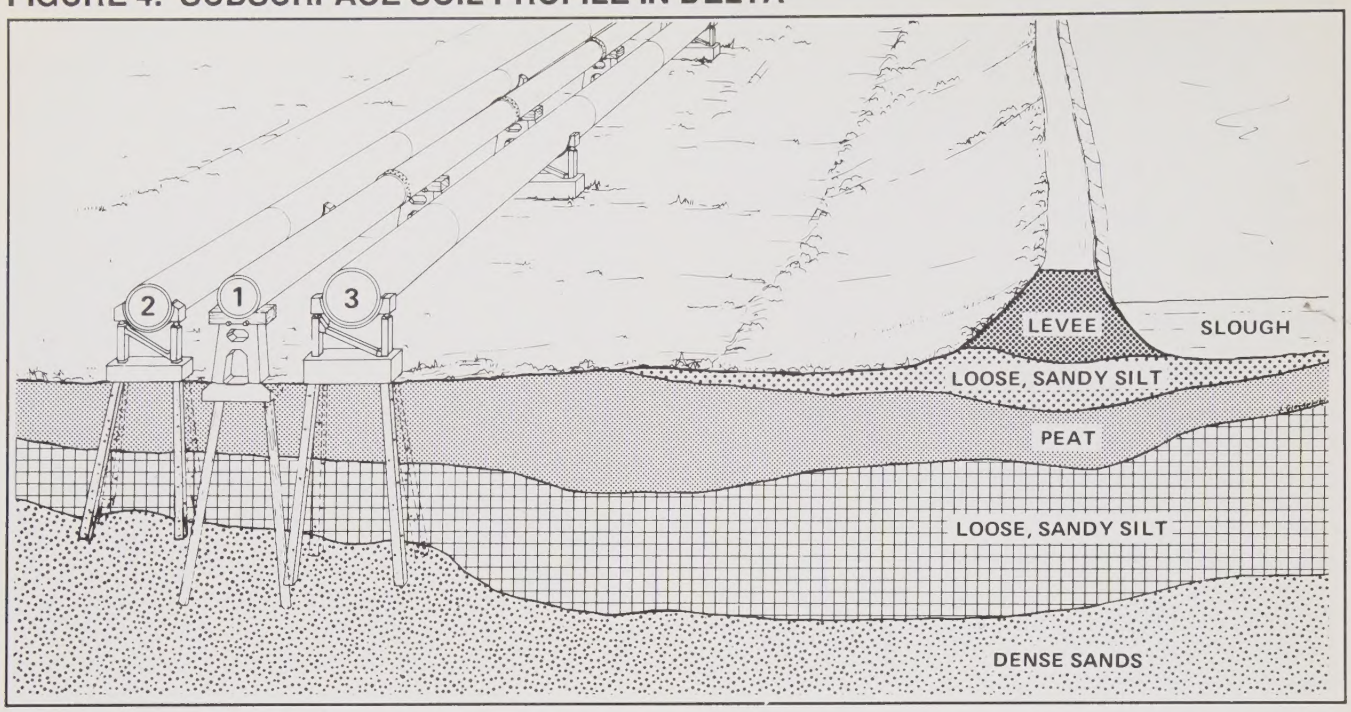


FIGURE 4. SUBSURFACE SOIL PROFILE IN DELTA



The Mokelumne Aqueducts are elevated above ground for 9 miles. The loose composition of Delta soils make the aqueducts vulnerable to floods

necessary reduction in demand under various conditions is shown in Table 2. Given the various threats, combined and individual, with greater frequency at lower levels, an outage time of 13 months has been assumed for planning purposes.

ALTERNATIVES FOR SECURITY

The alternatives for improving the security of EBMUD's water supply are listed in Table 4 and are discussed in this section. Table 11 on pages 20-21 is a summary comparison of the alternatives.

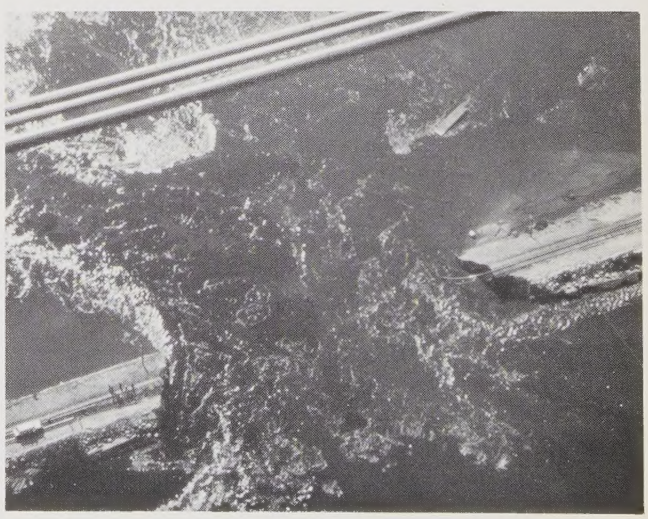
Do Nothing

To do nothing would mean a continuation of the current level of routine maintenance and patrolling of levees, but no substantial improvements. There would be continued deterioration of the conditions in the Delta, which over time would mean increased vulnerability of the aqueducts to an outage that could result in severe water rationing. EBMUD would be unprepared for such an outage, which would make it last longer than necessary.

Water Conservation

The alternative of expanding EBMUD's water conservation program to keep water demand during normal conditions at a low enough level to survive an extended outage of the Mokelumne supply would have to be based on extreme measures. The existing standby storage in the terminal reservoirs will accommodate a demand of only 82 MGD for 13 months, requring reductions of 138 MGD today and 188 MGD in 2020. A permanent reduction of demand to 83 MGD (63 to 70 percent reduction) would require extra-ordinary

FIGURE 5. 1980 JONES TRACT FLOOD AND SUBSEQUENT RAILROAD EMBANKMENT FAILURE



EBMUD pipelines at top of photo survived because of reduced flows through levee caused by low water levels and deflection due to presence of two locomotives and a box car. (One of the railroad cars is visible at right.)

FIGURE 6. HISTORIC DELTA FLOODING

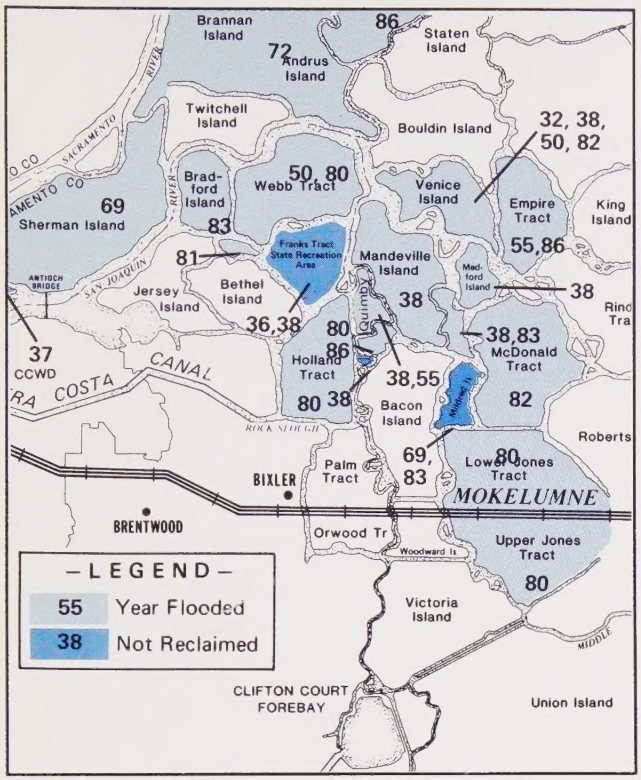
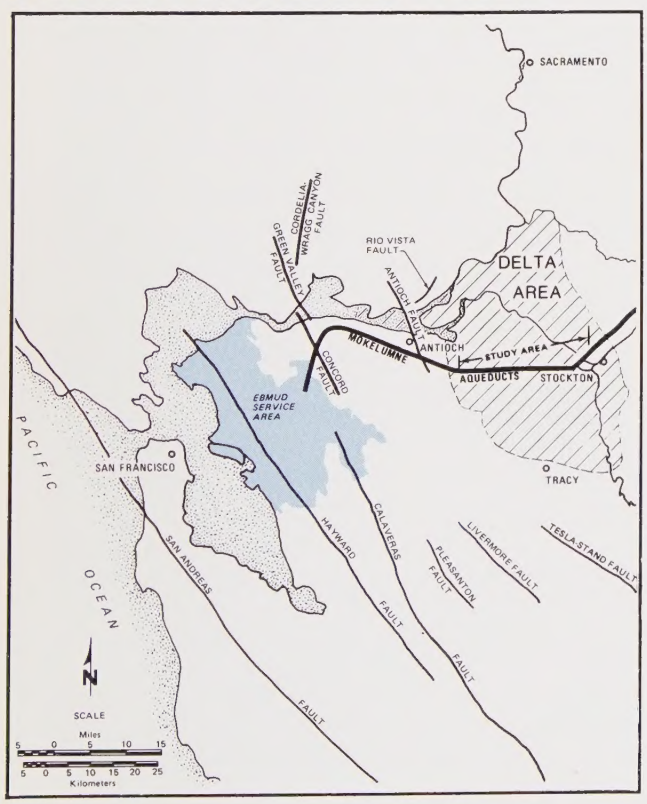


FIGURE 7. EARTHQUAKE FAULTS



changes in water use by residential, industrial, commercial, institutional, and irrigation customers, with significant investment by customers in water saving equipment. There would be a major impacts on the economy and lifestyle of the East Bay area.

Water conservation is discussed further under "Alternatives to Reduce Water Shortage," page 14.

Water Reclamation

The reuse of water through water reclamation is an option for non-potable water uses such as irrigation and industrial cooling. Feasible reclamation projects require a large non-potable demand in a limited area, close proximity to a wastewater source, and limited additional treatment requirements. Future reclamation projects could provide some additional savings, but not in the range of the 138 to 188 MGD reduction necessary to be able to survive a 13-month outage of the Mokelumne supply (see water conservation discussion above). When water uses are transferred to reclaimed water as a source, then the burden of demand reduction during an outage has to shift to other customers.

Water reclamation is discussed further under "Alternatives to Reduce Water Shortages," page 14.

Levee Improvements in the Delta

This alternative would involve completion of the minimum improvement work started in 1981, including minor repairs, upgrading, and raising the levees at river crossings and along the alignment of the elevated aqueducts. This would provide increased security against levee failure due to sloughing, erosion, or over-topping but not against ground shaking due to an earthquake.

Foundation Studies in the Delta

At the same time, preliminary engineering for future improvements in the Delta could be performed. These would include investigation and feasibility studies of levee reinforcement and

TABLE 2. DEFICIENCY DURING WATER SUPPLY OUTAGE

Potential Outage	Demand Reduction with Existing Storage (%)	
	1995	2020
10 Months	53	61
13 Months	64	69
17 Months	73	78

TABLE 3. TYPES OF AQUEDUCT FAILURE IN THE DELTA

EVENT	ESTIMATED DAMAGE	OUTAGE**
EARTHQUAKE		
Very high level of ground shaking (greater than 0.25g)*	Extensive levee failure and all islands and tracts flooded. Elevated aqueducts completely collapsed. Extensive damage to all buried pipelines and river crossings.	Up to 17 months
High level of ground shaking (0.2 to 0.25g)*	Levee breaks at many locations and most islands flooded. Elevated No. 1 Aqueduct completely collapsed. Elevated No. 2 and No. 3 aqueducts collapsed at several locations. Breaks in buried pipelines at several locations. Extensive damage to pipelines at one or more river crossings.	Up to 13 months
Low to moderate ground shaking (0.1 to 0.2g)*	Levee breaks at several locations and one or more islands or tracts is flooded. Elevated No. 1 Aqueduct extensively damaged. Elevated No. 2 and No. 3 Aqueducts damaged at a few locations. Possible breaks in buried pipelines. Some damage to pipelines at one or more river crossings.	Up to 10 months
FLOOD		
Single break near elevated aqueducts	Levee break at one or more locations. Scour from flow through levee undermines pile supports. One or more aqueducts opposite the break are damaged. The island or tract is flooded.	Up to 4 months

*Based on technical studies by independent consultants of ground acceleration due to an earthquake.

**Outage means severance of Mokelumne River water supply.

TABLE 4. ALTERNATIVES FOR IMPROVING SECURITY

1. DO NOTHING	
2. WATER CONSERVATION	2.1 Continue existing program 2.2 Landscape and water management 2.3 Ultra low flow toilets and showers 2.4 Water-saving technology 2.5 Landscape rebate program
3. WATER RECLAMATION	3.1 Chevron refinery and Alameda golf courses projects 3.2 San Ramon Valley irrigation
4. LEVEE IMPROVEMENTS IN THE DELTA	
5. NEW AQUEDUCT ACROSS THE DELTA	5.1 Limited capacity pipeline (one pipe) 5.2 Full capacity pipeline (two pipes)
6. WATER BANKING (Additional Terminal Storage)	6.1 Pinole Reservoir 6.2 Buckhorn Reservoir 6.3 Los Vaqueros Reservoir
7. INTERTIES WITH OTHER AGENCIES	7.1 Hayward treated water 7.2 Contra Costa Water District treated water 7.3 Hetch Hetchy untreated water 7.4 Alameda County Zone 7 treated water
8. USE OF DELTA WATER	8.1 No pretreatment 8.2 With pretreatment

See pages 20-21 for more detail about these alternatives..

modification of supports under the existing aqueduct pipelines and field testing and preliminary design of possible pile support systems and a future aqueduct pipeline across the Delta to shorten the response time in the event of a disaster. While this preliminary engineering is not an alternative for security, it would be an effective part of EBMUD's water management.

New Aqueduct Pipeline Across the Delta

An alternative that could provide secure delivery of the Mokelumne supply would be to construct a new pipeline across the Delta for a distance of 15 miles including three underwater river crossings. Part of or the full 325 MGD capacity of the present aqueducts would be provided by one or two pipelines elevated above ground on pile supported piers.

The pile supports would be designed to withstand major earthquakes and flooding given the foundation and levee conditions. However, there would be some risk in making a decision on the design considering the long life of such pipelines and uncertainties regarding continued deterioration of levees, subsidence of the islands, and the possibility of permanent inundation. That uncertainty is reflected in the uncertain plans of the State of California, the Corps of Engineers, and other agencies for levee and channel improvements.

Critical to the Delta pipeline alternatives are the reinforcement of levees at river crossings, which has not been attempted before, and the seismic design of the pile support systems. Prior to design and construction of a new pipeline, preliminary engineering studies and field testing would be required, which would take about four years.

Another consideration is the uncertainty about EBMUD's future water transmission needs when sizing new pipelines. Conditions that could require more othan 325 MGD capacity include the current comprehensive study of fish flow needs in the lower Mokelumne River, which might result in a limit on the times of diversion and require greater delivery over shorter periods. Also, future delivery of American River water from the Folsom South Canal could affect the need for aqueduct capacity.

Water Banking (Additional Terminal Storage)

The five functions of terminal reservoirs are described below. In this alternative, the amount of standby storage would be increased from the present capacity (120 days at full demand) to a level that would provide protection against as potential extended outage of the Mokelumne supply. At the projected demand of 270 MGD in the year 2020, the additional storage would be:

TERMINAL STORAGE: ITS FIVE FUNCTIONS

EBMUD has five terminal reservoirs in the East Bay hills, as shown in the map on the cover of this Summary. Together they provide a net usable storage capacity of 138,000 acre-feet.

Terminal storage has the following functions:

- **Emergency Standby** — storage maintained to meet demand during disruption or outage. It provides a minimum of 120 days of supply at normal demand to be able to cover disruptions while effective demand reduction measures are being implemented. This is the time needed to repair damage to tunnels, pumping plants, and pipelines. The 120-day reserve is maintained in drought conditions and provides a minimum storage carryover to the following year;
- **Regulation** — store Mokelumne River water in the winter and spring, when Sierra runoff occurs and demand is low, for use during the high demand period in the summer months. Both the 120-day standby and regulation storage requirements are independent of the source of supply, and at the current demand of 220 MGD, the storage required is 125,000 acre-feet. (See Figure 12).
- **Drought Reserve** — for meeting supply shortages in dry periods such as 1928-34, 1976-77, and 1987-88.
- **Develop Local Yield** — collect and store storm runoff from the reservoir watersheds. The storage capacity for regulation and local yield is referred to as "operational capacity" as shown in Figure 13 on Page 16.
- **Environmental Preservation and Recreation** — 26,000 acres of watershed land on which these reservoirs are located provide open space and water related recreation on 8,000 acres of water surface. These lands and water constitute a priceless urban refuge permanently protected from development. These watershed lands and the adjacent regional parks include an 80-mile system of trails wandering east of the Oakland-Berkeley Hills. (See discussion on page 19.)

Limit on Rationing	13-month Outage	17-month Outage
39%	100,000 AF	165,000 AF
25%	145,000 AF	225,000 AF

The 39 percent limit is existing policy; the 25 percent limit would be a change in policy to reduce the severity of rationing as discussed on Page 14. An outage of 13 months, a one in 83 years event, has been assumed for planning purposes.

The reservoir sites available for the additional storage required are Buckhorn and participation with Contra Costa Water District in its Los Vaqueros project. These are discussed later in this Summary.

Interties with Other Agencies

Studies by the Association of Bay Area Governments and others have dealt to a limited extent with interties. EBMUD has emergency connections with Hayward's distribution system (5 to 10 MGD) and has proposed doing the same with Martinez and Dublin San Ramon Services District. However, no utility has a significant long-term surplus, and each has long-term commitments and facilities in place that would make it difficult for interties to substitute for the other alternatives presented in this report. In addition, water rights and environmental issues associated with any change in sources or service areas could be significant. Nevertheless, intertie possibilities are included for discussion.

Delta Water Use

During the 1976-77 drought, EBMUD was concerned about the possible extent of the drought and pumped water from the Delta with potentially adverse effects on the health of its consumers (see Experience with Delta Water on p. 18). During an extended outage resulting from flooding in the Delta, quality could be degraded even further due to salt water intrusion in addition to the continuing inflows of agricultural drainage.

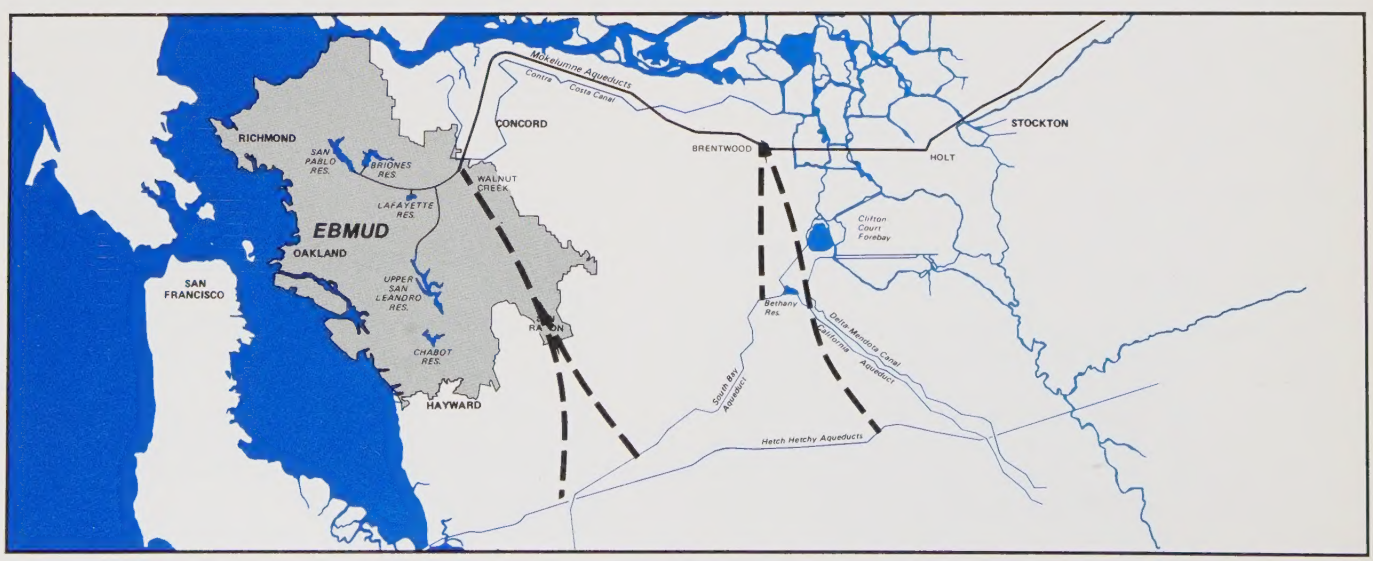
The District's major treatment plants are not equipped to treat Delta water. To be able to plan on using Delta water during an extended outage of the Mokelumne supply would require construction of pretreatment and desalinization facilities at the source. Pretreatment would remove turbidity, disinfect, and reduce the THM formation potential. Additional facilities at the existing filter plants would help process for THM reduction. Desalinization would involve reverse osmosis treatment to reduce the elevated levels of total dissolved solids because of the extremely high salinity expected. The brine resulting from desalinization would have to be disposed of, perhaps by pumping it to San Francisco Bay. This treatment would not necessarily eliminate the concern about future health risks associated with contaminants.

The District's 1985 Citizens Advisory Committee recommended against diversion from the Delta, and state and federal policy urges providing water from the highest quality source. It would not be desirable to deliver the principal supply to EBMUD users from a source like the Delta for 13 months.

Groundwater Resources

There are no groundwater resources of appreciable size located within East Bay Municipal Utility District, so this is not a viable alternative for security improvements.

FIGURE 8. INTERTIE CONCEPTS



SHORTAGE: SUPPLY TO MEET DRY YEAR DEMANDS

EBMUD operates an extensive water supply system (see Figure 2 and the data on Table 5). This system has not been augmented since the mid-1960s.

EXISTING CONDITIONS

Precipitation

California is a semi-arid state. Its historic rainfall and tree-ring records indicate great fluctuations in precipitation by area and quantity. The best modern science cannot provide reliable forecasts of precipitation for more than a week in advance. EBMUD's source of supply is the spring runoff from the snowpack in the Mokelumne watershed. Its use by customers is determined by the seasonal rainfall in the Bay Area.

Water Demand

In the past 25 years the number of customers served by EBMUD has increased 20 percent and water use by 30 percent. In 1987, total use reached 220 MGD. The breakdown by categories of customers is shown in Table 6. Residential customers create 62 percent of the total demand.

Water Conservation and Reuse

EBMUD's policies and practices provide for continuing improvement in water use efficiency and reliance on rationing in extremely dry periods. In the early 1970s, EBMUD began a pioneering effort in water conservation education with school programs and materials now used nationwide. This effort has expanded, and today there is a full time staff at the District's Water Conservation Office in Alamo administering a program which includes the measures listed in Table 9.

Water Supply Availability Policy

The District has the legal right and capacity to divert up to 325 MGD from the Mokelumne River. Water is available at Pardee Reservoir except during drought periods of two or more years when the supply of water from the Mokelumne, in conjuction with existing storage, would be only 215 MGD, which is the firm yield. This number is declining as water users upstream of Pardee Reservoir with higher priority rights increase their diversions. When demand exceeds the available supply, the District must rely on water from terminal storage reservoirs to help meet demand, and has imposed mandatory rationing when storage was not sufficient to make up for the shortage of supply (1977 and 1988).

In 1985, the District responded to the increasing risk of shortage by adopting a Water Supply Availability and Deficiency Policy. It anticipates drought cycles and assumes a voluntary 25 percent use reduction in the last half of the first year of shortage and a mandatory 39 percent reduction of use in the second year. The 39 percent Districtwide use reduction was achieved in 1977, but will be increasingly difficult to achieve due to the steadily improving efficiency of industrial, commercial, and residential water use as discussed in the box on Page 14.

A voluntary reduction was tried in 1987 without success, and that experience shows that it should not be planned for in the last half of the first year of a drought.

Figure 9 shows that the 39 percent limit on rationing during a drought affects the availability of the supply in normal years for planning purposes. The current planning level is 252 MGD, and will decline to 222 MGD by the year 2020. The

TABLE 5. EBMUD SUPPLY SYSTEM

SOURCES OF SUPPLY

Mokelumne River - 325 MGD
Terminal Reservoirs - up to 10 MGD
Contract with U.S. Bureau of Reclamation - 134 MGD

STORAGE - MOKELUMNE RIVER

Pardee Reservoir - 211,000 acre-feet of storage for water supply and power generation.
Camanche Reservoir - 430,000 acre-feet of storage for stream flow regulation, flood control, senior water rights, and power generation.

DELIVERY SYSTEM

Mokelumne Aqueducts
No.1 65" pipeline (1928)
No.2 67" pipeline (1948)
No.3 87" pipeline (1963)
Gravity flow up to 200 MGD
Pumped flow up to 325 MGD

STORAGE - TERMINAL RESERVOIRS

Briones	(1964)	60,500 acre-feet
Chabot	(1875)	10,300
Lafayette	(1928)	4,200
San Pablo	(1919)	38,600
Upper San Leandro	(1926)	41,400
TOTAL		155,000 acre-feet

WATER TREATMENT PLANTS

Lafayette	(1953)	48 MGD
Orinda	(1935)	175
San Pablo	(1921)	60
Sobrante	(1965)	60
Upper San Leandro	(1927)	83
Walnut Creek	(1967)	80

MGD = Million Gallons per Day

39 percent limit would be exceeded after demand in normal years reaches about 240 MGD between 2000 and 2005.

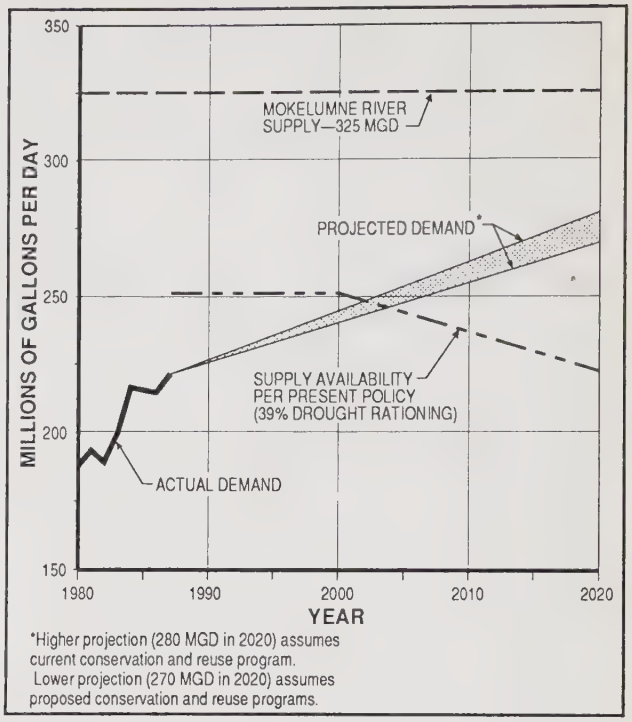
PROJECTED NEEDS

Projected Increase in Demand

Water demand within EBMUD's ultimate boundary is projected to increase from the current 220 MGD (in a normal year) to a level between 247 and 294 MGD by the year 2020. As shown in Figure 9, a projection of 270-280 MGD assumes a mid-range growth rate. For planning purposes, 270 MGD is used, assuming full implementation of EBMUD's current water conservation and reuse programs plus proposed additional measures and projects. EBMUD's ultimate boundary defines the planning limits of its future service area at 385 square miles (see map on cover). It includes potential development on annexable private lands of about 3 square miles. Service to areas beyond the ultimate boundary is not included in the projected demand, except for the recently annexed areas east of Danville and San Ramon.

Increase in water demand is determined by the residential and commercial development planned and approved by the cities and counties within the District. Demand has been projected on the basis of population, housing, employment, and land use projections by the Association of Bay Area Governments (ABAG) to the year 2005 for the area within the ultimate boundary. Longer term county projections by the State Department of Finance were used for extension to the year 2020. The demand projection takes into account the differences in geographic, climatic, and land use characteristics across the EBMUD service area, which have a significant bearing on water use. Indicative of the expected growth are the projections of households within EBMUD, as shown in Figures 10 and 11.

FIGURE 9. PROJECTED DEMAND



*Higher projection (280 MGD in 2020) assumes current conservation and reuse program. Lower projection (270 MGD in 2020) assumes proposed conservation and reuse programs.

Service Obligation

As a utility, EBMUD has an obligation to provide water service to properties located within its boundaries and to annexed territory within its ultimate boundary as the cities and counties plan and permit new development. To accommodate this service obligation, EBMUD must anticipate the future needs of existing customers and assure that the water supply system is adequate for the projected increase in demand.

TABLE 6. WATER DEMAND IN 1986

CATEGORY	WATER USE (MGD)			PERCENTAGE OF OVERALL TOTAL
	Indoor	Outdoor	Total	
Residential - Single Family	50	41	91	42
Residential - Multi-Family	23	8	31	14
Commercial and Institutional	25	7	32	15
Industrial - Petroleum	14	1	15	7
Industrial - Other	14	1	15	7
Parks, Golf and Cemeteries	1	11	12	6
Micellaneous Water Use	—	—	2	1
District Water Use	—	—	1	1
Unaccounted for Water	—	—	16	7
		TOTAL	215	100 %

FIGURE 10. POPULATION AND HOUSEHOLDS

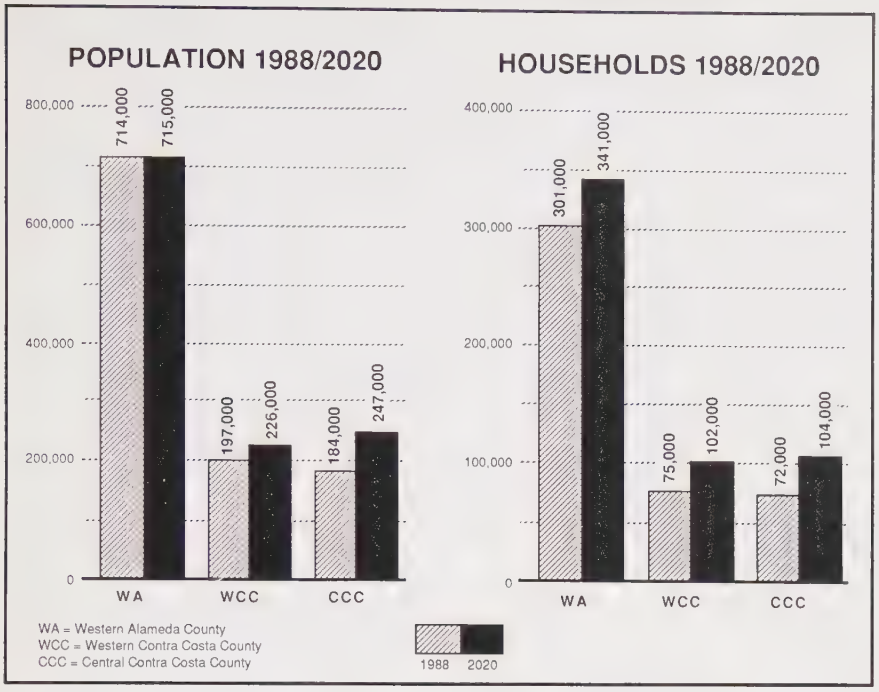


FIGURE 11. RESIDENTIAL USE

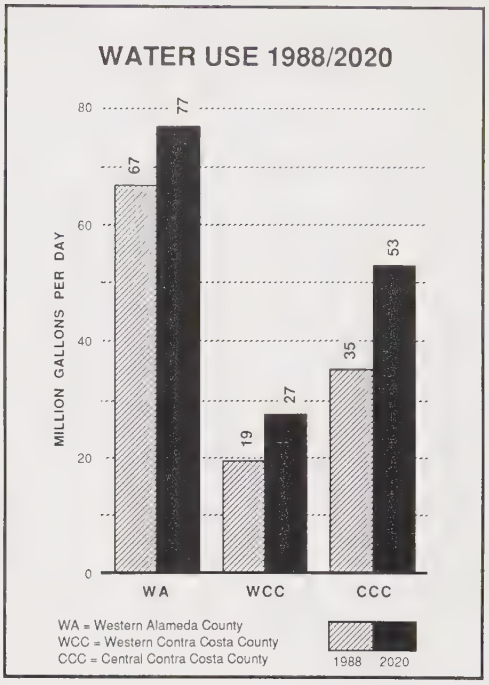


TABLE 7. ALTERNATIVES TO REDUCE WATER SHORTAGES

1. DO NOTHING	
2. WATER CONSERVATION	2.1 Continue existing program 2.2 Landscape and water management 2.3 Ultra low flow toilets and showers 2.4 Water-saving technology 2.5 Landscape rebate program
3. WATER RECLAMATION	3.1 Chevron refinery and Alameda golf courses projects 3.2 San Ramon Valley irrigation
4. LEVEE IMPROVEMENTS IN THE DELTA	Not applicable to the problem of drought shortage
5. NEW AQUEDUCT ACROSS THE DELTA	Not applicable to the problem of drought shortage
6. WATER BANKING (Additional Terminal Storage)	6.1 Pinole Reservoir 6.2 Buckhorn Reservoir 6.3 Los Vaqueros Reservoir
7. INTERTIES WITH OTHER AGENCIES	7.1 Hayward treated water 7.2 Contra Costa Water District treated water 7.3 Hetch Hetchy untreated water 7.4 Alameda County Zone 7 treated water
8. USE OF DELTA WATER	8.1 No pretreatment 8.2 With pretreatment
9. OTHER SOURCES OF WATER	9.1 Exchange with Woodbridge Irrigation District 9.2 Purchase of additional Mokelumne River water
See pages 24-25 for more detail about these alternatives.	

ALTERNATIVES TO REDUCE WATER SHORTAGES

The alternatives for improving EBMUD's capability of meeting dry year water demands are listed in Table 7, summarized in Table 11 (pp. 20-21), and are discussed in this section.

Do Nothing

To do nothing would mean no reduction in dry year and drought shortages, no opportunity to reduce the severity of planned rationing during drought periods, and within about 15 years a required level of rationing in excess of 39 percent in a repeat of 1976-77 conditions.

Water Conservation

The proposed water conservation program consists of the existing program plus the additional measures shown in Table 9. The additional measures are those found to have the potential for being successful in achieving water savings and are considered to be the most reasonable, feasible, and publically acceptable. Because EBMUD has water available in excess of its needs most of the time, the approach has been to select voluntary measures. Additional savings of about 2 MGD are projected by the year 2020, for a total of 6 MGD.

EBMUD and other entities have studied most if not all of the conceivable water conservation measures. Many of these have either never been used, are difficult to quantify, or can be implemented only through radical changes in use practices. They were not considered to be feasible for the alternative water conservation program, but are listed as potential measures. The role of pricing in water conservation is discussed on p. 17.

The potential conservation measures could be included in the program for pilot testing. As indicated on Table 9, there is much more that EBMUD can do on water conservation. How much depends on future analyses and study, the costs and benefits of each measure, and the impacts of

DROUGHT USE WATER LIMITS

The District's supply from the Mokelumne River is 325 MGD. The limit on demand reduction in a repeat of drought conditions affects the availability of the supply for planning purposes. While a 39 percent overall reduction in demand was achieved in 1977, the impact on many District customers was significant. The loss of landscaping alone was estimated at $75 million. In addition, industrial and institutional customers became more efficient in their water use by installing new equipment and devices, repairing leaks, and modifying processes. This increased efficiency, together with more efficient plumbing fixtures in new construction and increased use of low water use landscaping, means that a rationing program today to achieve a 39 percent reduction will cause a much greater hardship than it did in 1977. As water conservation efforts continue to improve water use efficiency, the same reduction will become even more difficult. This is shown in Table 8 as the achievable reduction in drought.

In light of this and also to reduce the severity of rationing to a more reasonable level, the planned maximum reductions for the various categories of customers could be reduced as shown in Table 8, with an overall maximum reduction of 25 percent.

TABLE 8. DEMAND REDUCTION IN DROUGHT

CUSTOMER CATEGORY	ACTUAL DEMAND REDUCTION IN 1977	ACHIEVABLE REDUCTION IN 1988	ACHIEVABLE REDUCTION IN 2020	REDUCED SEVERITY IN DROUGHT
Residential				
— Single family	49%	44%	42%	35%
— Multi-family	23%	23%	20%	15%
Commercial and Institutional	39%	34%	28%	25%
Industrial				
— Petroleum	18%	12%	0%	0%
— Other	29%	9%	5%	5%
Parks, Golf and Cemeteries	55%	47%	35%	30%
OVERALL	39%	35%	31%	25%

more efficient uses in terms of EBMUD's ability to respond in a drought and the lifestyles of individual residents. Indoor and outdoor use practices of new residents are being changed and can be further changed, but the volume saved will be small. Changing existing plumbing and gardens is expensive, unprecedented, and benefits will occur only in periods of shortage when users will save the same or more without the expense of long-term changes in home conditions.

Ultra low flow toilets (1.5 gallons per flush) is an emerging technology with a potential for measurable water savings. The additional measures include support for legislation for ultra low flow toilets and showers in new construction. Replacement of existing customers' toilets would be considered later, although the cost would be very high.

Water Reclamation and Reuse

The current reclamation program saves approximately 4.8 MGD of potable water, as shown in Table 10.

Additional projects can replace about 5 MGD of the existing supply. As more reclamation projects are implemented, particularly for large water users like a golf course or oil refinery, the potable water supply increases. In the event of a drought, reclaimed water users benefit because they are not faced with the consequences of a water shortage. But there is also a negative effect. During a drought, significant reductions in irrigation water use contribute to the overall achievable reduction in demand. When those uses are supplied by reclaimed water, then the burden of demand reduction has to shift to other customers.

TABLE 9. WATER CONSERVATION

EXISTING PROGRAM ALTERNATIVE 2.1		ADDITIONAL MEASURES ALTERNATIVES 2.2 & 2.3		THEORETICAL MEASURES** ALTERNATIVES 2.3, 2.4, & 2.5	
Measure	**Water Savings***	**Measure**	**Water Savings***	**Measure**	**Water Savings***
Leak Detection and Pipeline Rehabilitation	--	Water Audits for Industrial Processes	1.1	Landscape Rebate	1.3
Water Metering	--	Expand Landscape Consultations	0.2	Ultra Low Flow Toilets and Showers in New Construction	2.1
Water Saving Device Distribution	1.9	Irrigation Management of Large Landscaped Areas	0.4	Mandatory Toilet Replacement for Residential Customers	12.8
Water Audits	0.9	Support Legislation for Ultra Low Flow Toilets and Showers in New Construction	--	Mandatory Toilet Retrofit for Non-Residential Customers	0.5
Landscape Consultations	0.1	Additional Demonstration Gardens	--	Water Efficient Technology	0.7
Landscape Water Use Efficiency in New Developments	1.1	Landscape Rebate Pilot Program	--	Potential Additional Savings	17.4
Demonstration Gardens	--	Irrigation Upgrade Pilot Study	--		
Public Information and School Education	--	Additional Savings	1.7		
Total Savings	4.0				

*Projected additional water savings (in MGD) by the year 2020

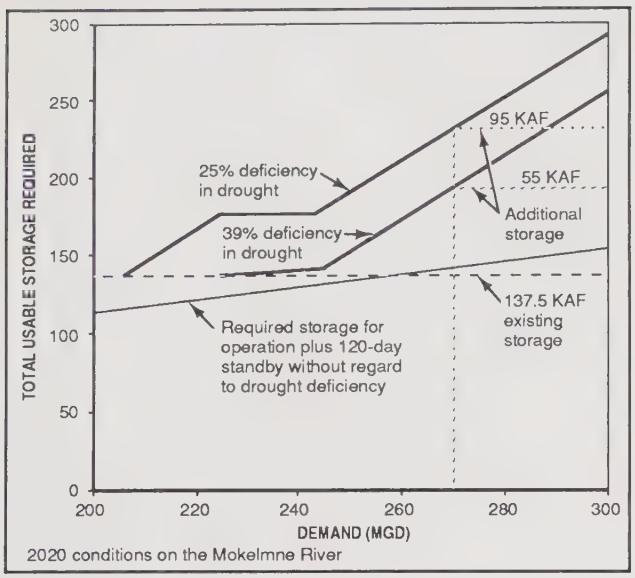
**These measures may have the potential for additional water savings but they are costly, have unproven records and/or impose mandatory restrictions.

***Water saving may not be additive due to overlap of measures.

TABLE 10. WATER RECLAMATION

EXISTING PROGRAM	ADDITIONAL PROJECTS
EBMUD Special District 1 wastewater treatment plant -- landscape irrigation,general washdown, and industrial cooling (2.0 to 2.5 MGD)	**Alameda Golf Courses** -- expansion of Galbraith Golf Course Project to golf courses in Alameda (0.5 MGD)
EBMUD Filter Plants (water treatment) -- reclamation of filter backwash water (2.0 MGD)	**Chevron Oil Refinery, Richmond** -- cooling water from West Contra Costa Sanitary District treatment plant; pilot study completed; estimated startup in 1991 (potential 4.7 MGD)
Richmond Golf Course -- irrigation water from West Contra Costa County Sanitary District treatment plant (0.16 MGD)	**San Ramon Valley** -- irrigation water from Dublin San Ramon Services District treatment plant; planning study (potential 1.4 MGD)
Galbraith Golf Course -- irrigation water from San Leandro wastewater treatment plant (0.15 MGD)	

FIGURE 12. TERMINAL STORAGE NEEDED TO MEET WATER DEMAND



2020 conditions on the Mokelmne River

Water Banking

The water supply functions of terminal storage are described on page 9. Water banking made available by the construction of additional terminal storage would limit the severity of rationing during drought periods by increasing the supply.

The ability to meet demand during the second year of a drought period is based on a balance between the amount of water available from the Mokelumne River, the extent to which demand is reduced by a rationing program, and the amount of terminal storage available in addition to the basic 120-day standby. As shown in Figure 12, storage under the 120-day criteria and with a 39 percent limit on rationing is adequate today. However, additional storage will be needed to stay within drought rationing limits in the future. At the projected demand of 270 MGD in 2020, an additional 55,000 acre-feet of storage are needed to stay within a 39 percent limit and 95,000 acre-feet are needed to stay within a 25 percent limit. Beyond 2020 (about 25 years after a project could be in service), the storage need will be greater.

The reservoir sites available for the additional storage required are Pinole, Buckhorn, and participation with Contra Costa Water District in its Los Vaqueros project. These are discussed later in this Summary.

Interties with Other Agencies

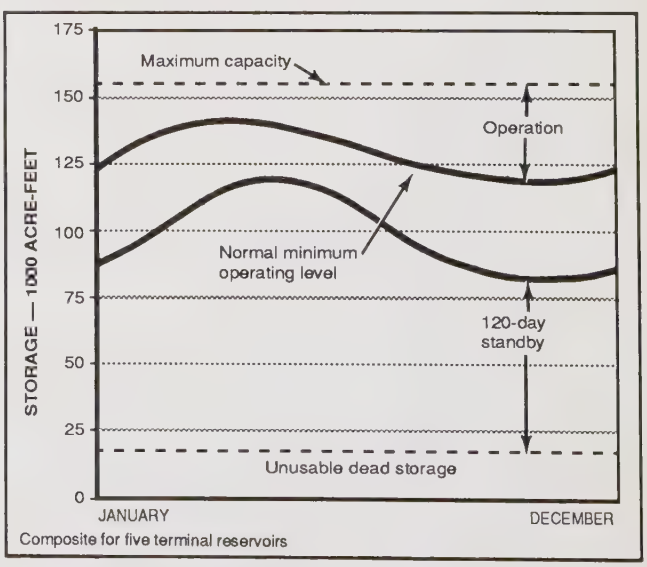
The potential for interties with adjacent and nearby water supply systems of other agencies is discussed earlier in the Security section. An intertie with San Francisco's Hetch Hetchy system would have no benefit in times of shortage during a drought when San Francisco also has deficiencies. The Contra Costa Water District may have a limited quantity (about 15 MGD) of treated water available from its Bollman Treatment Plant on a seasonal basis, but this may not be a long-term alternative.

The State Water Project pumps water from the southern Delta to Bethany Reservoir for the California Aqueduct and for the South Bay Aqueduct extending to southern Alameda County and Santa Clara County. A major transmission pipeline would be needed for a connection, and the quality of Delta water is inconsistent with EBMUD's treatment systems and water quality policy.

Delta Water Use

Water from the Delta is adequate in quantity, but its quality is inconsistent with EBMUD's treatment system and water quality policy. It is of significantly lower quality than the Mokelumne River, and there is a concern about future public health risks associated with contaminants. The water quality in the Delta is at its worst during dry periods when EBMUD's Mokelumne River supply is reduced. Furthermore, EBMUD's water treatment facilities and processes are based on using a high quality source of water and would require extensive capital improvements to treat Delta water. To be able to plan on using Delta water during a drought shortage would require construction of pretreatment facilities at the source to remove turbidity, disinfect, and reduce the THM formation potential. Additional facilities at existing filter plants would help reduce the THM formation potential. Even then, although safe, the treated water would be of lower quality.

FIGURE 13. CURRENT USE OF TERMINAL STORAGE



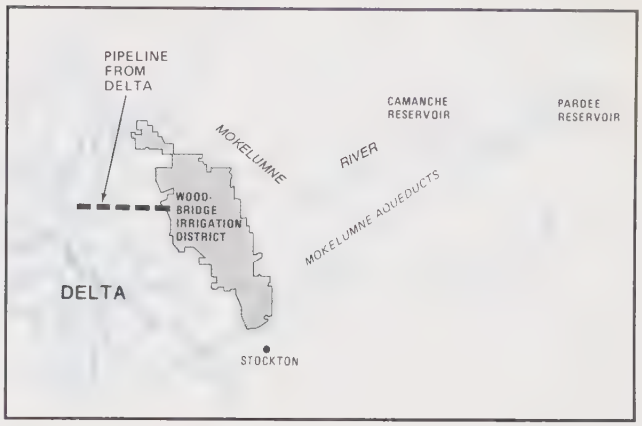
Composite for five terminal reservoirs

Other Sources of Water

Under EBMUD's agreements with the Woodbridge Irrigation District and the Woodbridge Water Users Conservation District, which recognize the relative rights to Mokelumne River water, EBMUD releases enough water from Camanche Reservoir so that a permanent supply of 29,000 to 60,000 acre feet per year (depending on inflow to EBMUD's reservoirs) is available for use by the Woodbridge districts, with additional releases until 1992 for an additional interim supply of 26,855 to 56,700 acre-feet per year.

In the Woodbridge exchange concept, EBMUD would enter into an agreement to provide a water supply to those districts from the eastern Delta in dry years in exchange for a reduction in their use of Mokelumne River water. EBMUD's attempts to exchange water with the Woodbridge districts have not been successful. Another approach has been to try direct purchase of water from the Woodbridge districts and other users on the lower Mokelumne River or development of a conjunctive use project. Discussions between EBMUD and the Woodbridge districts are continuing.

FIGURE 14. WOODBRIDGE EXCHANGE



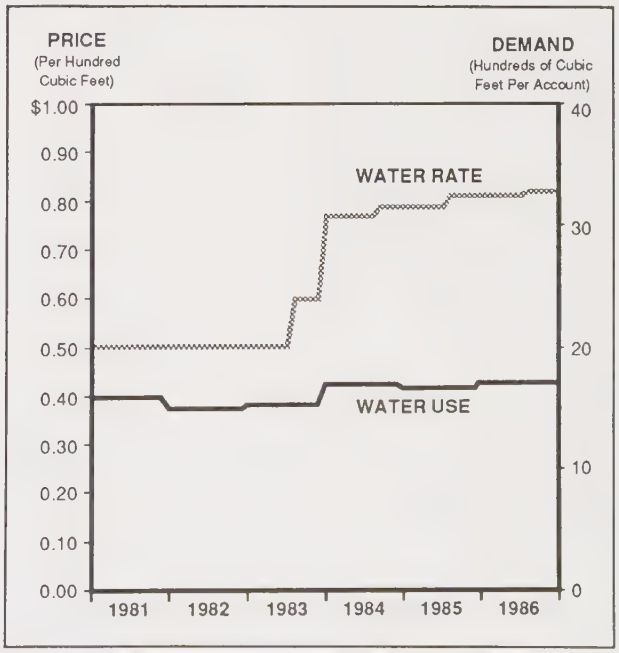
The resulting decrease in river flows below Camanche Reservoir would be a significant concern to the fish and wildlife agencies and would have an adverse impact on the groundwater basin unless recharge in normal and wet years can be enhanced.

THE ROLE OF PRICING AND RATES

EBMUD has studied the impact of the 50 percent increase in charges for water to higher elevations in recent years. Analysis indicates no significant reduction in water use despite this large increase, contrary to popular perception. (See Figure 15.) Other utilities have had similar experiences. The general low level of water rates compared to other public services does not put water charges in an effective price-demand relationship.

The 1977 experience with water rationing and severe financial penalties, however, indicates that when coupled with a true emergency, a severe price penalty for excessive use can be effective. Small changes in water rates with average bills running between $10 and $20 per month will in most instances not impact a user's water use pattern. Public policy, education on efficient use, incentives and a gradual shift in the approach to landscaping will in time have more impact on water use than rates except in industrial and commercial applications where there is a direct relationship between the water used and the cost of the product. Even so it is a relatively small part of most industries' operating costs. Also there is a price-use relationship with agricultural water deliveries, but the District has no such customers.

FIGURE 15. PRICE vs. DEMAND IN ELEVATED ZONES



SAFETY AND HEALTH: HIGHEST WATER QUALITY

COMMITMENT TO THE CLEANEST AND SAFEST SUPPLY

In the 1920s, when Pardee Reservoir was constructed on the Mokelumne River, the primary reason for developing a Sierra supply (as opposed to other sources closer to the Bay Area) was the high quality of that source. Today there is even greater reason for using high quality water from the Mokelumne. Increasing regulatory requirements in the 1980s, together with the growing availability of health effects information, make it clear that, to provide customers with high quality water, it is necessary to start with the best available source and to treat that supply with the best available treatment. The California Department of Health Services (DOHS) has reiterated its long standing policy that:

> "Water utilities should seek to obtain the cleanest water source practical and provide all reasonable protection of the supply from any known or potential source of contamination hazard."

EBMUD has six filter plants that treat all the water delivered to its customers. (See Table 5.) With the high quality source, the filter plants produce high quality water that is well above current drinking water standards as shown in Figure 16.

ISSUES AND CONCERNS

Watershed Protection

The 577-square mile Mokelumne River watershed above Pardee Reservoir is predominantly national forest land and almost entirely undeveloped. In the East Bay hills, EBMUD and East Bay Regional Park District own most of the land tributary to the five terminal reservoirs, but the cities of Orinda and Moraga are also within two watersheds. EBMUD protects the quality of its supply by monitoring and where possible controlling activities within the watersheds that could lead to contamination.

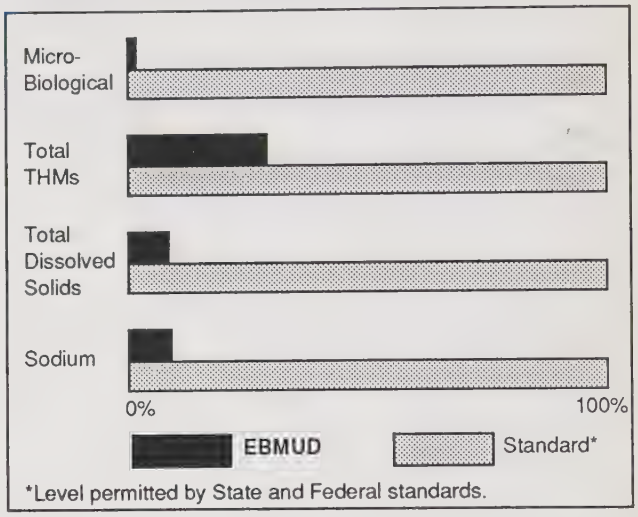
Federal Standards

The 1986 amendments to the federal Safe Drinking Water Act will have a major impact. The Environmental Protection Agency (EPA) is now preparing new regulations to implement the amendments, which will place emphasis on reduction of organic chemicals in drinking water. Even meeting today's water quality standards cannot assure that public health requirements will be met in the future. The best strategy is not to just meet standards, but to minimize contaminants.

Trihalomethanes

The most significant known health risk in treated surface supplies is caused by trihalomethanes

FIGURE 16. EBMUD WATER QUALITY COMPARED TO EPA STANDARDS



(THMs). These are suspected cancer-causing compounds resulting from the disinfection of water with chlorine, which reacts with naturally occurring organic compounds to form THMs. The standard for THMs is currently 100 micrograms per liter (ug/L), but there is serious consideration within EPA to lower it to 20 ug/l. EBMUD's THMs are now about 25 ug/l. The THM formation potential is four times higher in the Delta than the Mokelumne.

Taste and Odor

Water delivered through EBMUD's main filter plants in Orinda, Lafayette and Walnut Creek is the very highest esthetic quality. Although there are occasional episodes of chloronous tastes, these have been minimized. However water delivered through Sobrante, San Pablo and Upper San Leandro filter plants from the terminal reservoirs is subject to the summertime problem of algae growth causing taste and odor. These filter plants are being upgraded with the latest technology to minimize if not eliminate the taste and odor problems.

Experience with Delta Water

During the 1976-77 drought, EBMUD used Delta water mixed with existing supplies. Significant taste and odor problems were experienced in San Pablo and Upper San Leandro Reservoir water. When Delta water was added to Upper San Leandro Reservoir the THM levels doubled. A high proportion of the THMs were caused by elevated levels of bromide in Delta water caused by sea water intrusion. Brominated THMs have been confirmed recently to be more potent as carcinogens.

NEEDED IMPROVEMENTS

Watershed Management and Improvement

EBMUD owns 26,000 thousand acres of watershed land in the Bay Area. Of this, 8,000 acres is water surface. In addition, the East Bay Regional Park District and other public agencies own 20,000 thousand acres of continuous open space. This is a permanent public asset which involves 80 miles of interconnected trails. Extensive treatment is provided, though, for the water from San Pablo and Upper San Leandro Reservoirs which contain drainage from the Cities of Orinda and Moraga. The Briones Reservoir watershed is almost entirely in public ownership.

Watershed management would be improved by EBMUD's purchase of watershed lands currently in other ownership and which may have a potential for development. Acquisition of the land to the ridgelines around the terminal reservoirs to the extent possible would help assure that the high quality of stored water can be maintained into the future. The San Pablo and Briones watersheds could benefit by acquisition of a total of 972 acres at an estimated cost of $6.7 million. The Upper San Leandro watershed could benefit by acquisition of 498 acres at a cost of $3.0 million plus the acquisition of the Buckhorn Reservoir watershed of approximately 678 acres at an estimated cost of $2.5 million. The watershed around the Pinole Reservoir site would involve purchase of 24 parcels totaling 2,687 acres at an estimated cost of $16.1 million.

These acquisitions would also minimize ridgeline development in the Moraga/Orinda area and provide opportunities for new trails .

Treatment Improvements and Studies

Although EBMUD treated water is superior to state and federal standards, EBMUD continues to pursue advanced water treatment technology. Approximately $35 million in treatment plant improvements are in process or planned to meet these objectives.

An extensive alternative treatment technologies evaluation is underway at EBMUD, designed to decrease chemical use while producing a higher quality product. One technology being considered is membrane filtration, which is thought to remove turbidity, bacteria, Giardia, and other particulates without the addition of coagulants. Reducing the use of chemicals is consistent with EBMUD's objective of keeping to a minimum the amount of chemicals introduced into the treatment process.

USBR CONTRACT - AMERICAN RIVER SUPPLY

EBMUD has had a contract with the U.S. Bureau of Reclamation since 1970 for a supplemental supply of up to 150,000 acre-feet per year (134 MGD) from the American River, to be delivered via the Folsom South Canal. EBMUD has not constructed the facilities needed to take delivery because of litigation since 1972. The prospect is for continued delays as the lawsuit moves through the trial and appellate courts. Even if the supplemental supply was available immediately, it would not address the Water Supply Management Program objectives for security and shortage.

The Report of Referee issued by the State Water Resources Control Board in June 1988, and now under consideration by the trial court, supports EBMUD's need for the supplemental supply. However, it recommends that EBMUD would have to cease taking delivery of water at times when flows in the lower American River drop below specified minimum levels. Thus in dry years there would be limitations on the amount of water available, and in a drought year like 1977 EBMUD could not take delivery of any American River water.

Security against an extended outage is needed regardless of the source--Mokelumne or American River. A pipeline from the turnout on the Folsom South Canal to the Mokelumne Aqueducts would be the most direct and least expensive connection, which means that the American River supply would be interrupted the same as the Mokelumne supply in the event of a disaster in the Delta. Furthermore, the dry year limitations could be in effect during an extended outage.

Water banking would help utilize the supplemental supply for other than security purposes, and the amount of additional storage needed for drought shortage alone could be reduced by about 28 percent. However, the amount of additional storage proposed for the Water Supply Management Program is governed by the capacity needed for security (Table 13), with or without the supplemental supply. That means a decision now to construct an additional terminal reservoir would not be based on whether the USBR contract will be implemented in the future.

For these reasons, the USBR contract is not an alternative in the Water Supply Management Program and the current water supply problems must be resolved independent of the future American River supply. It will be part of EBMUD's long range water supply planning. Separate environmental documentation will be prepared for the facilities needed to deliver the supplemental supply to EBMUD.

TABLE 11. ALTERNATIVES

1. DO NOTHING	2. WATER CONSERVATION				
	2.1 Existing Program	**2.2 Landscape and Water Management**	**2.3 Ultra Low Flow Toilets & Showers**	**2.4 Water Saving Technology**	**2.5 Landscape Rebate Program**
DESCRIPTION OF ALTERNATIVE					
Continue present levels of existing water conservation (no further implementation) and water reclamation programs, current levels of levee maintenance, and no new projects.	Continue to implement: • Device distribution • Water audits • Landscape consultation • Establish landscape water use efficiency guidelines	Additional measures: • Expand consultations • Audits for industries • Irrigation management • Pilot studies of landscape rebate • Residential wellwater use	Support adoption of state law requiring ultra low flow fixtures in new construction. After, mandated for new construction, consider requiring replacement on resale or subsidy for existing customers.	For non-residential customers, require retrofit devices on sanitary fixtures and latest water saving technology for cooling water and industrial process water.	Provide monetary rebate to encourage customers to replace existing landscaping with low water landscaping.
MEETS OBJECTIVES?					
No. Continued problem of deficient supply in outages and droughts.	No. But would reduce demand by 4 MGD.	No. But would reduce demand by an additional 2 MGD.	No. But could reduce demand by an additional 2.1 and 12.8 MGD.	No. But could reduce demand by about 1.2 MGD.	No. But could reduce demand by about 1.3 MGD.
COST (Total EBMUD and Consumer Costs)					
——	$0.3 million per year	$0.5 million per year	Replacement program $10-13 million per year	$0.1 million per year plus consumer cost.	$0.1 million per year plus consumer cost.
REMARKS					
——	Current program also includes leak detection, pipeline rehabilitation, water metering, demonstration gardens, public information & school education.	These are feasible measures that can be implemented.	Emerging technology. Uncertain acceptance by existing customers because of high consumer cost for replacements.	May be difficult to administer. If cost effective technology exists, customers will use it without regulations.	Untested measure. Pilot program is included in Alternative 2.2.

6. WATER BANKING - ADDITIONAL TERMINAL STORAGE			7. INTERTIES WITH OTHER AGENCIES		
6.1 Pinole Reservoir	**6.2 Buckhorn Reservoir**	**6.3 Los Vaqueros Reservoir**	**7.1 Hayward Treated Water**	**7.2 CCWD Treated Water**	**7.3 Hetch Hetchy Untreated Water**
DESCRIPTION OF ALTERNATIVE					
Construct terminal reservoir at EBMUD's Pinole site with 50,000 acre-feet of storage. Includes tunnel, pipeline, and pumping plant.	Construct terminal reservoir at EBMUD's Buckhorn site: • 100,000 acre-feet for 39% rationing. • 145,000 acre-feet for 25% rationing. Includes tunnel, pipeline, and pumps.	Participate in CCWD project at the Los Vaqueros site: • 110,000 acre-feet for 39% rationing. • 155,000 acre-feet for 25 % rationing. Includes tunnel, pipeline, and pumps.	Negotiate agreement with Hayward for use of existing interties (Hetch Hetchy water).	Negotiate agreement with CCWD and construct intertie at CCWD's Bollman treatment plant.	Negotiate agreement with San Francisco and construct interconnecting pipeline (27 miles) and pumping plant between Hetch Hetchy and Mokelumne Aqueducts.
MEETS OBJECTIVES?					
Security: Partially - 36 MGD. Shortage: Partially - 39 MGD.	Security: Yes - 82-119 MGD. Shortage: Yes - 41-78 MGD.	Security: Yes - 82-119 MGD. Shortage: Yes - 41-78 MGD.	Security: Partially - 5-10 MGD.. Shortage: No.	Partially, 15 MGD seasonal.	Security: Uncertain, but may be about 30 MGD. Shortage: No
COST					
$60 million	100,000 AF-$133 mil. 145,000 AF-$160 mil.	110,000 AF-$370 mil. 155,000 AF-$398 mil.	None	$1 million	$100 million
REMARKS					
With 39% limit on rationing, would provide 9.3 months of supply. With 25% limit, 7.6 months. Cost of initial filling $5 million.	Size based on security needs. Cost of initial filling $12 million to $18 million.	Size based on security needs. Cost of initial filling $8 million to $11 million. If 100% Sierra water is used the cost would be reduced by $211 million.	Not expected to be available in drought shortage.	Detailed investigation needed to develop project and availability.	Not expected to be available in drought.

	3. WATER RECLAMATION		4. LEVEE IMPROVEMENTS IN THE DELTA	5. NEW AQUEDUCT ACROSS THE DELTA	
	3.1 Chevron and Alameda Projects	3.2 San Ramon Valley Irrigation		5.1 Limited Capacity Pipeline	5.2 Full Capacity Pipelines
DESCRIPTION OF ALTERNATIVE					
	Complete the Chevron refinery cooling water project in Richmond; develop and construct the Alameda Golf Courses irrigation project.	Develop and construct an irrigation project in the San Ramon Valley for golf courses and greenbelts.	Complete current levee repair and upgrading work and develop and implement a program of futher levee improvements.	Construct one 86" pipeline across the Delta designed to survive flooding and ground shaking due to an earthquake - 15 miles elevated; 3 river crossings.	Construct two 86" pipelines across the Delta designed to survive flooding and ground shaking due to an earthquake - 15 miles elevated; 3 river crossings.
MEETS OBJECTIVES?					
	No. But would reduce demand by 5.2 MGD.	No. But potential to reduce demand by about 1.4 MGD.	No. But increases security against levee failures.	Security: Yes - up to 170 MGD. Shortage: No.	Security: Yes - up to 325 MGD. Shortage: No.
COST (Total EBMUD and Consumer Costs)					
	$15.5 to 16.6 million	$1,000 per acre-foot	$8 million	$175 million (minimum)	$265 million (minimum)
REMARKS					
	Pilot study for Chevron has been completed.	Previous study showed project would not be economically feasible without more users.	Would not provide any physical protection against ground shaking due to an earthquake.	Requires studies and field testing of design concepts. Would not provide additional supply in drought.	Requires studies and field testing of design concepts. Would not provide additional supply in drought.

		8. USE OF DELTA WATER		9. OTHER SOURCES OF WATER		10. WATERSHED ENHANCEMENT
	7.4 Alameda County Zone 7	8.1 No Pretreatment	8.2 With Pretreatment	9.1 Exchange with Woodbridge	9.2 Purchase Mokelumne Water	
DESCRIPTION OF ALTERNATIVE						
	Negotiate agreement with Santa Clara Valley WD and Alameda County Zone 7 for treated Delta water. Pipeline and pumping plant required.	Complete the construction of Bixler Emergency Pumping Plant to be used in an unexpected emergency.	Construct pretreatment facilities for Delta source to remove turbidity, disinfect, and reduce THM potential. Construct desalinization to reduce TDS.	Negotiate agreement and construct facilities to supply Woodbridge districts with Delta water; in exchange receive up to 39,000 acre-feet of Mokelumne water.	Negotiate agreement for direct purchase of Mokelumne water from Woodbridge districts, or develop conjunctive use project to achieve same results.	Improve watershed management and protection of water quality by purchase of land to ridgelines around terminal reservoirs. (Approx. 3,500 acres).
MEETS OBJECTIVES?						
	Security: Uncertain, but may be 5-10 MGD. Shortage: Uncertain, but may be 5-10 MGD.	No. Not acceptable to plan on using Delta water without adequate treatment.	Security: Yes, with desalinization. Shortage: Yes.	Security: No. Shortage: Partially - up to 35 MGD.	Security: No. Shortage: Partially.	Safety and Health: Yes.
COST						
	$10 million (approximate)	———	$200 to $545 million	$25 million	Not yet known.	$20 million
REMARKS						
	Detailed investigation needed to develop project and availability.	State Health Department limits this to unforseen emergencies. Planned use requires treatment facilities.	Range of cost depends on treatment for THMs and method of brine disposal.	EBMUD's attempt to exchange water has not been successful. Discussions are continuing.	EBMUD's attempts to puchase water have not been successful. Discussions continue regarding conjunctive use.	Acquisitions could minimize ridgeline development in Orinda/ Moraga area and allow more trails.

COMPOSITE PROGRAM OPTIONS

The security and shortage alternatives in Table 11 can be combined into a variety of composite program options to reduce future demand and provide additional supplies during outage and drought as solutions to EBMUD's water supply problems. The program options in Table 12 illustrate the combinations of alternatives that can be compared and considered in arriving at the proposed program. Every option includes water conservation (Alts. 2.1 and 2.2), reclamation (Alt. 3.1), levee improvements (Alt. 4), and watershed enhancement (Alt. 10).

The information provided in the table has been expanded from previous drafts of this report in response to public comments such as an editorial in the Oakland Tribune last fall. Several possible variations of Options 2 and 4 are described. In addition, program costs have been expanded to include present worth costs of future operation and maintenance and of potential future replacement of aqueduct pipelines in the Delta due to a major earthquake (assumed in 2030 for purpose of calculation). The estimated costs of the Buckhorn Reservoir project and EBMUD's share of the Los Vaqueros Reservoir project of CCWD have been increased to reflect the most recent data regarding project elements and requirements.

Option 1 - Conservation and Reclamation
Water conservation and reclamation are the principal focus in this option, enhanced by low cost treated water interties and conjunctive use on the lower Mokelumne River area to try to solve the security and shortage problems.

Water conservation includes all conservation alternatives. The untested, more-theoretical measures in Alternatives 2.3, 2.4, and 2.5 could increase the potential water savings to 21 MGD, but should first be subject to pilot testing to develop the requirements and expected benefits. Ultra low flush toilets (Alt. 2.3) is an emerging technology getting attention in some parts of the country, and would be the biggest part of the increased savings. But it also has a high consumer cost for the replacement of existing toilets. Water reclamation includes the feasible Chevron and Alameda projects (Alt. 3.1).

EBMUD has attempted, without success, to develop an exchange project or purchase water from the Woodbridge districts. Discussions are continuing, but with emphasis on the potential for development of a conjunctive use project. Only the Hayward and Contra Costa Water District treated water interties are included in this option because of their low cost. The availability of any water from another agency in time of drought shortage would be uncertain.

Option 1 would not solve the security and shortage problems because of the significant water supply deficiencies that would still remain.

Option 2 - Delta Pipeline and Water Banking
The combination of a new aqueduct pipeline across the Delta and water banking with a new terminal reservoir could solve the security and drought shortage problems. The pipeline would only provide security, and water banking would provide the increase in carryover supply needed during drought shortages. The variations of the option are based on different reservoir sites, limited or full capacity aqueduct pipelines, and the limit on rationing during an outage or drought shortage.

Water banking only for shortages would be smaller as shown in Table 13. If the limit on rationing is reduced to 25%, then only the Buckhorn and Los Vaqueros sites can provide sufficient capacity.

The uncertainties about future Delta conditions, the need for investigations and studies, and other considerations affecting a decision to build a new aqueduct pipeline or pipelines across the Delta are discussed on Page 9.

Option 3 - Use of Delta Water
Delta water could provide the quantity needed for solving the security and drought shortage problems. However, because of the low water quality, particularly in the event of a disaster in the Delta, the future use of Delta water without adequate treatment is not acceptable. While limited use of Delta water without full treatment has been permitted in unexpected emergencies, its planned use would not be allowed by the State Health Department. Therefore, pretreatment facilities are included in this option to remove turbidity, disinfect, and reduce the trihalomethane formation potential. Even with this pretreatment the ability to use Delta water to help meet demand during a drought shortage would depend on the quality of water at the time of diversion, which may be negatively impacted by the reduction in freshwater flows.

In the event of an outage caused by an earthquake disaster in the Delta, the salinity is expected to be too high to permit any use of Delta water if only conventional pretreatment is provided. Therefore, desalinization is also part of the pretreatment alternative. A problem with desalinization is the need to dispose of the brine generated by the reverse osmosis treatment process. Pretreatment does not eliminate the concern about the long-term health risks associated with use of Delta water.

TABLE 12. PROGRAM OPTIONS

OPTION NUMBER	AMOUNT OF STORAGE	PIPELINE CAPACITY	LIMIT ON RATIONING		SOURCE OF WATER FOR RESERVOIR	ESTIMATED COSTS	
			DROUGHT	OUTAGE		CAPITAL	PROGRAM
1	**CONSERVATION AND RECLAMATION** Emphasis on conservation and reclamation in normal years, but does not solve the problems.					71	327
2	**DELTA PIPELINE AND WATER BANKING** New aqueduct pipeline for security and water banking with smaller reservoir for shortages.					See below	See below
	PINOLE SITE FOR STORAGE						
2a	50,000 AF	PARTIAL	39%	25%	Mokelumne	281	401
2b	50,000 AF	FULL	39%	0%	Mokelumne	371	440
	BUCKHORN SITE FOR STORAGE						
2c	95,000 AF	PARTIAL	25%	25%	Mokelumne	348	476
2d	95,000 AF	FULL	25%	0%	Mokelumne	438	516
2e	55,000 AF	PARTIAL	39%	25%	Mokelumne	303	423
2f	55,000 AF	FULL	39%	0%	Mokelumne	393	463
	LOS VAQUEROS SITE FOR STORAGE (joint project with CCWD)						
2g	103,000 AF	PARTIAL	25%	25%	Mokelumne & Delta	586	737
2h	103,000 AF	FULL	25%	0%	Mokelumne & Delta	676	776
2i	60,000 AF	PARTIAL	39%	25%	Mokelumne & Delta	510	654
2j	60,000 AF	FULL	39%	0%	Mokelumne & Delta	600	693
NOTE: If 100% Sierra water is used to fill Los Vaqueros, then capital costs for 2g-2j would be reduced by $211 million and program costs would be $513 million, $552 million, $431 million and $470 million.							
3	**USE OF DELTA WATER** Planned use of fully treated Delta water during outage and shortages.					540	707
4	**WATER BANKING** Additional terminal storage for both security and shortages.					See below	See below
	BUCKHORN SITE						
4a	145,000 AF	—	25%	25%	Mokelumne	205	370
4b	100,000 AF	—	39%	39%	Mokelumne	178	333
	LOS VAQUEROS SITE (joint project with CCWD)						
4c	155,000 AF	—	25%	25%	Mokelumne & Delta	443	628
4d	110,000 AF	—	39%	39%	Mokelumne & Delta	415	591
NOTE: Option 4a is the option proposed for the Water Supply Management Program. If 100% Sierra water is used to fill Los Vaqueros, then capital costs for 4c and 4d would be reduced by $211 million and the program costs would be $404 million and $367 million.							

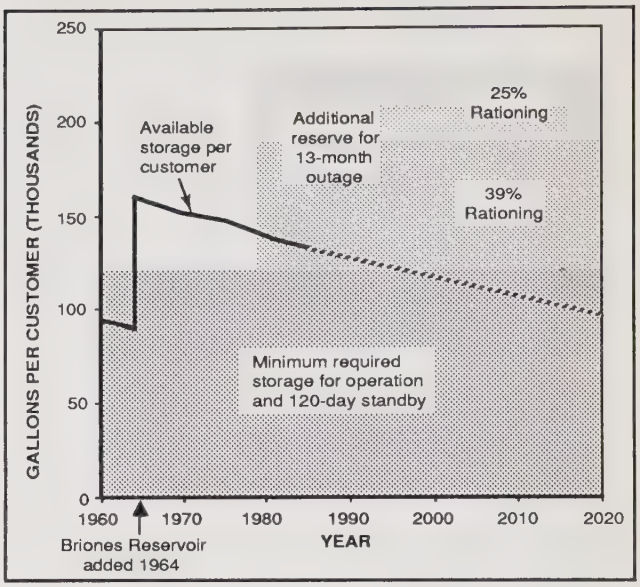
Option 4 - Water Banking -- Additional Storage
Water banking by the construction of additional terminal storage could solve both the security and the drought shortage problems. The variations of the option in Table 12 are based on the two different reservoir sites and the limit on rationing during an outage or drought shortage. The capacity needed in Los Vaqueros is larger than Buckhorn due to greater flood control and dead storage volumes.

Description and evaluation of the three reservoir sites is covered on pages 25 through 28.

The Most-Feasible Option
Water banking by the construction of an additional terminal reservoir at the Buckhorn site appears to be the most feasible and cost effective solution to EBMUD's water supply problems (Figure 17). It would be a multi-purpose solution and would also meet the water quality objective related to safety and health because the stored water would be entirely from the Mokelumne River. Figure 18 shows the storage needs per customer and how that has changed over the years.

Although the option with storage at Los Vaqueros assumes that CCWD's water source for filling the reservoir will be the Delta, resulting in a blend of Sierra and Delta water, it is included as an option because there will be an opportunity for CCWD to purchase surplus Mokelumne water from EBMUD and CCWD's long term objective is to secure a Sierra source of supply.

FIGURE 18. STORAGE AVAILABILITY



The additional storage capacity required for surviving a drought like 1976-77 and surviving a 13-month outage of the Mokelumne supply (Figure 19) are separate considerations. Table 13 shows the capacity needed for a condition where a major earthquake affecting the Delta and a worst-case drought occur in immediate sequence. However, the risk of sequential events is very small and the proposed storage should therefore be based on security, which has a greater requirement than drought shortage.

FIGURE 17. STORAGE RESULTS IN INCREASED SUPPLY

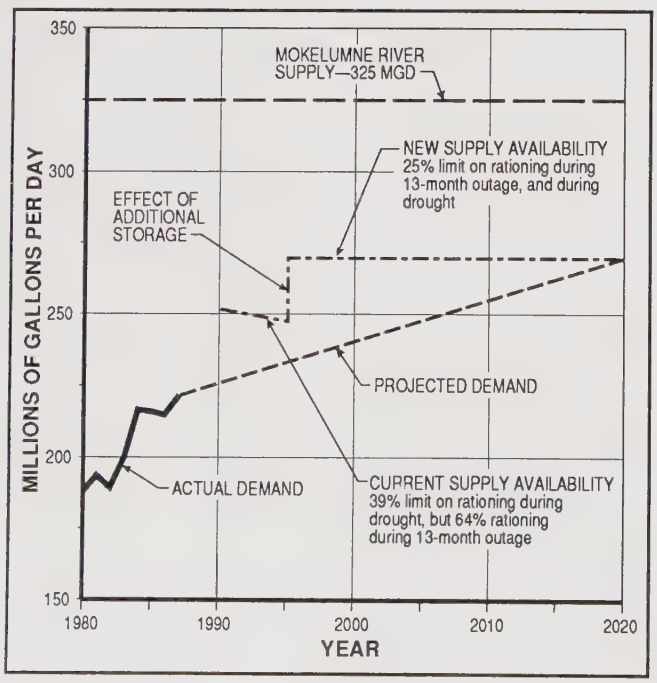
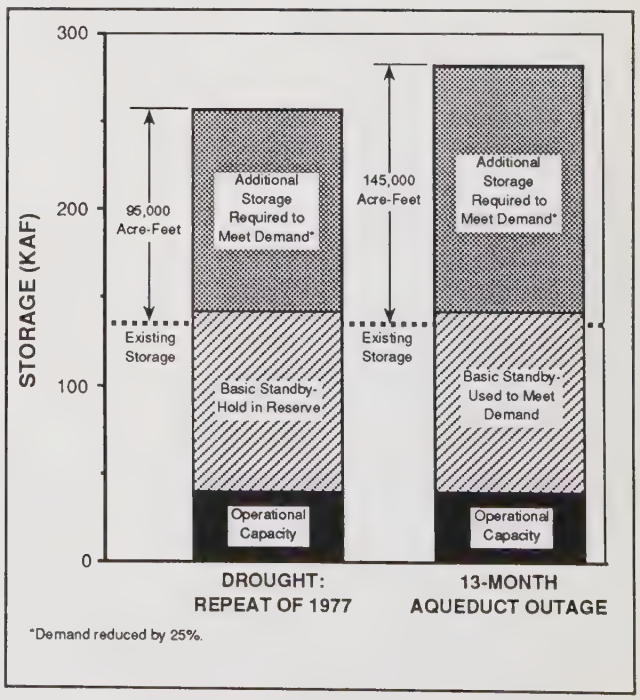


FIGURE 19. STORAGE REQUIRED FOR 270 MGD IN 2020



EVALUATION OF RESERVOIR SITES

A total of 26 potential reservoir sites were identified within and near EBMUD's service area. These were evaluated from the standpoint of available capacity, comparative cost, and land use considerations. The three most feasible sites are Pinole, Buckhorn, and Los Vaqueros. Table 14 describes the technical features of the projects and the environmental effects are summarized on pages 26-28.

EBMUD owns the Pinole site and a large part of its watershed, and owns all but a small part of the Buckhorn site and its watershed. Los Vaqueros will be a project owned and operated by the Contra Costa Water District. EBMUD's participation would be through an agreement covering joint planning and operations and the sharing of costs. Financing could be handled through a joint powers agreement.

The Los Vaqueros alternative includes pretreatment facilities at a cost of $200 million to be able to use a Mokelumne/Delta blend of water in EBMUD's system. These would include sedimentation, ozonation, and granulated activated carbon (GAC). If Los Vaqueros is filled and operated with 100% Sierra water the pretreatment facilities would not be needed.

Table 12 shows the potential use of the three reservoir sites in the various program options for either water banking for both security and shortages or a combination of Delta pipeline for security and water banking for shortages (smaller reservoir).

TABLE 13. ADDITIONAL STORAGE

LIMIT ON RATIONING	SECURITY: 13-MONTH OUTAGE	SHORTAGE: DROUGHT LIKE 1977-78	COMBINED EVENTS
39%	100,000 AF	55,000 AF	150,000 AF
25%	145,000 AF	95,000 AF	235,000 AF

TABLE 14. RESERVOIR PROJECTS

ALTERNATIVE	ELEMENTS	COST
PINOLE RESERVOIR 50,000 AF Spillway elevation 340' Dam 180' high	Pumping plant at San Pablo Dam Road. Pipeline in right of way and Castro Ranch Road. Inlet-outlet tunnel.	$60 million
BUCKHORN RESERVOIR 100,000 AF Spillway elevation 700' Dam 325' high	Pumping plant near St. Mary's College. Pipeline in Camino Pablo, Canyon Road, Moraga Road and St. Mary's Road. Inlet-outlet tunnel.	$133 million
BUCKHORN RESERVOIR 145,000 AF Spillway elevation 745' Dam 370' high		$160 million
LOS VAQUEROS RES. 110,000 AF for EBMUD 220,000 AF assumed total Spillway elevation 540' Dam 250' high	Pumping plant near Mokelumne Aqueducts. Pipeline connection to Mokelumne Aqueducts. Pretreatment facilities for blend of Sierra and Delta water ($200 million). Separate inlet-outlet tower and tunnel ($11 million).	$370 million
LOS VAQUEROS RES. 155,000 AF for EBMUD 265,000 AF assumed total Dam 265' high		$398 million

TABLE 14. ALTERNATIVE RESERVOIR SITES

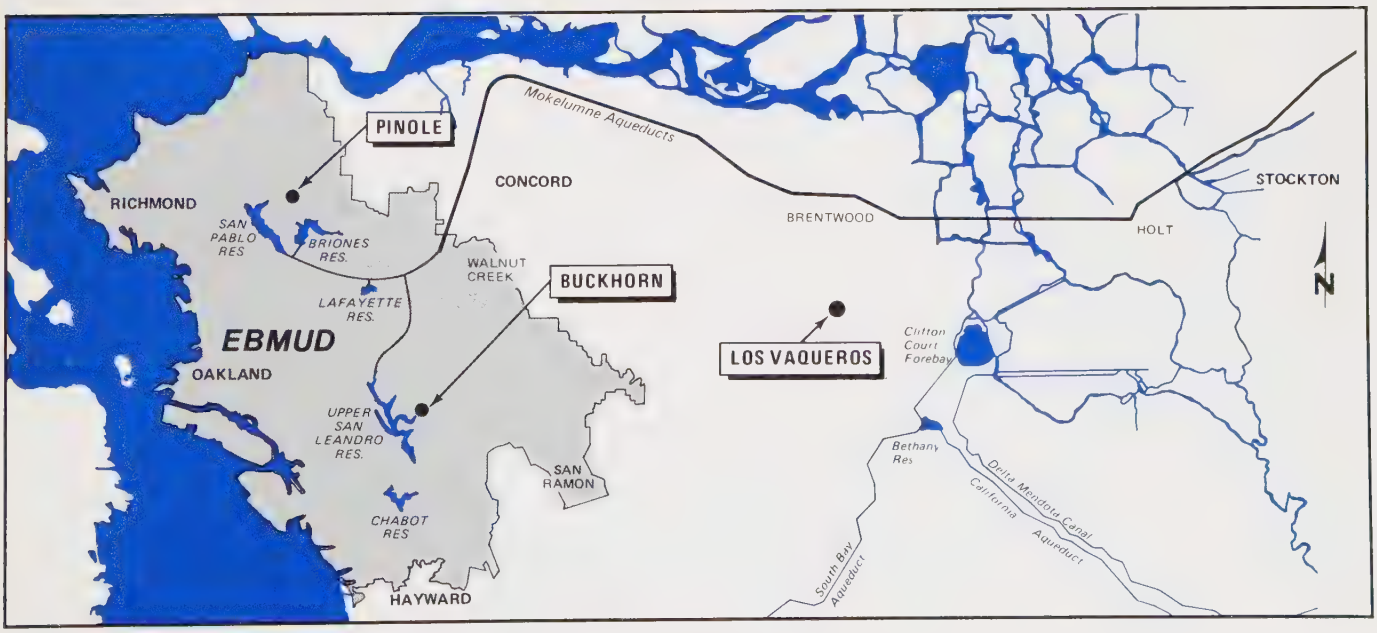
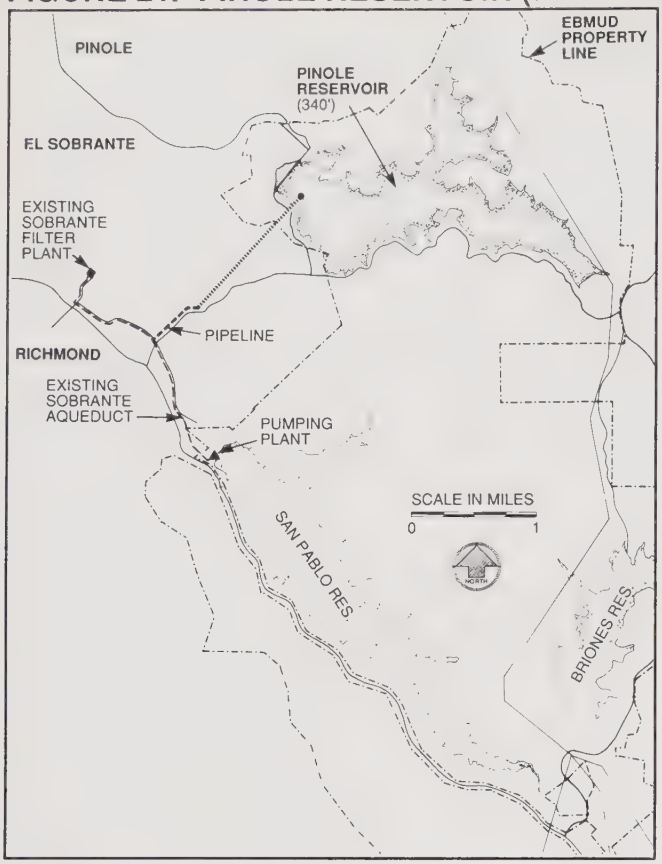


FIGURE 21. PINOLE RESERVOIR (ELEV. 340')



PINOLE RESERVOIR

Construction Access

- Pipeline and inlet-outlet tunnel -- from I-80 freeway via San Pablo Dam Road to Castro Ranch Road.
- Pumping plant -- from I-80 freeway via San Pablo Dam Road to the base of San Pablo Dam.
- Dam -- from I-80 freeway via Pinole Valley Road, or via Castro Ranch Road, and Alhambra Valley Road to the damsite.

Construction Time

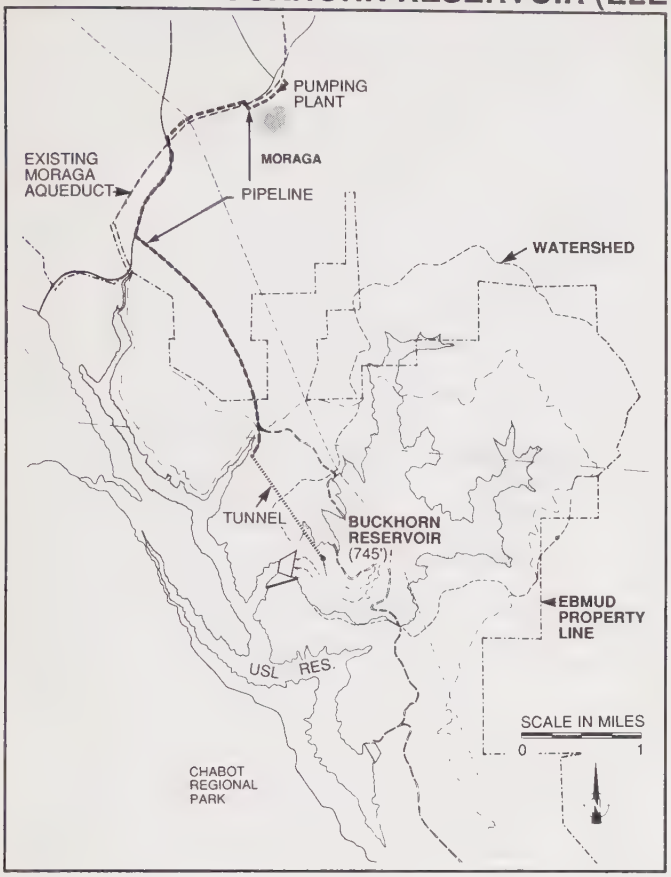
- Pipeline in Castro Ranch Road -- a limited construction area progressing in stages along the pipeline route for an estimated total 2 months, coordinated with school schedules, holiday periods, and other community activites.
- Pumping plant at the base of San Pablo Dam -- estimated 20 months for excavation, structure construction, and installation of piping, pumps, and electrical equipment.
- Reservoir inlet-outlet tunnel -- estimated 12 months for excavating the tunnel and installing the pipe.
- Dam -- estimated 2 1/2 years total time, including about 16 months for embankment and spillway construction.

Pipeline Alternatives

- Alternatives to the pipeline for connection of Pinole Reservoir to the water supply system include other tunnel and pipeline alignments at an additional cost of $0 - 4 million.

PINOLE RESERVOIR		
POTENTIAL ENVIRONMENTAL EFFECTS		**MITIGATION**
• Land Use	800 acres of cattle grazing land converted to body of water	Acquire additional watershed land to the ridgelines; provide trail extensions.
• Hydrology and water quality	Potential erosion during construction. Beneficial effect on water supply availability. Improved flexibility in meeting flow requirements in lower Mokelumne River.	Use appropriate methods to control erosion.
•Geology and soils	No active faults pass through dam site. Exposure of facilities to seismic hazards.	Use appropriate technology to protect soils; design dam to resist maximum credible earthquake.
• Vegetation and wildlife	54 acres of riparian vegetation inundated; Aleutian Canada goose found near dam site; black walnut trees on the site may be native.	Enhance riparian habitat on other watershed land.
•Traffic disruption	Pipeline construction in Castro Ranch Road; relocation of Pinole Valley Road.	Appropriate traffic controls and detours as needed.
• Construction traffic	Temporary increase in traffic: Pinole Valley Road 12%; Castro Ranch road 2%; I-80 1%.	Schedule time of traffic; coordinate with cities and counties.
• Noise and air quality	Equipment noise; dust during construction.	Mufflers on equipment. Dust suppression.
• Cultural resources	One site of potential archeological interest.	Exploratory site excavation; recording prior to completion of project.
• Visual quality	Permanent change in appearance of site. Relocation of power transmission lines.	Consider esthetics in design of dam and other facilites.
• Public health and safety	Unquantifiably small risk of dam failure. Will reduce shortages caused by drought or outage.	Design dam to resist maximum credible earthquake.
• Growth inducement	Will provide capacity for development planned and permitted by cities and counties.	None required.

FIGURE 22. BUCKHORN RESERVOIR (ELEV. 745')



BUCKHORN RESERVOIR

Construction Access

- Pipeline and pumping plant construction -- from Highway 24 freeway via Moraga Way to Moraga Road and St. Mary's Road and to Canyon Road and Camino Pablo.
- Reservoir inlet-outlet tunnel -- from Highway 24 freeway, via Moraga Way, Canyon Road, and Camino Pablo to King Canyon.
- Dam -- from I-580 freeway via Castro Valley Blvd., Redwood Road, and Miller Road to the staging area below Upper San Leandro Dam and to the damsite.

Construction Time

- Pipeline through Moraga -- a limited construction area progressing in stages along the pipeline route for an estimated total 10 months, coordinated with school schedules,holiday periods, and other community activities.
- Pumping plant at St. Mary's College -- estimated 20 monthsfor excavation, structure construction, and intallation of piping, pumps, and electrical equipment.
- Reservoir inlet-outlet tunnel at damsite -- estimated 10 months for excavating the tunnel and installing the pipe.
- Dam -- estimated 3 1/2 years total time, including about 24 months for embankment and spillway constuction.

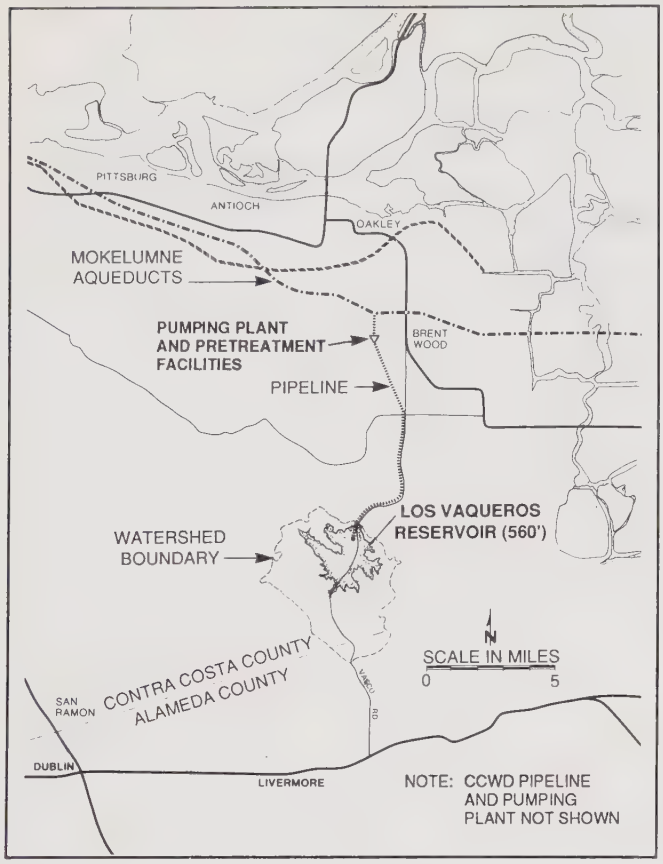
Pipeline Alternatives

- Alternatives to the pipeline between Buckhorn Reservoir and the pumping plant at St. Mary's College include tunnels for part or all of the route to minimize construction in streets at an additional cost of $5 - 15 million.

BUCKHORN RESERVOIR

POTENTIAL ENVIRONMENTAL EFFECTS		MITIGATION
• Land Use	1124 acres of cattle grazing land converted to body of water	Acquire additional watershed land to the ridgelines; provide trail extensions.
• Hydrology and water quality	Potential erosion during construction. Beneficial effect on water supply availability. Improved flexibility in meeting flow requirements in lower Mokelumne River.	Use appropriate methods to control erosion.
• Geology and soils	No active faults pass through dam site. Exposure of facilities to seismic hazards.	Use appropriate technology to protect soils; dam designed to resist maximum credible earthquake.
• Vegetation and wildlife	34 acres of riparian vegetation inundated; No rare or endangered species found; loss of spawning habitat for steelhead rainbow trout.	Create and enhance riparian habitat on adjacent watershed land; coordinate with fish and wildlife agencies.
• Traffic disruption	Pipeline construction in St. Mary's Rd., Moraga Rd., Canyon Rd., and Camino Pablo.	Appropriate traffic controls and detours as needed.
• Construction traffic	Temporary increase in traffic: Redwood Rd./Castro Valley 15%; Castro Valley Blvd. 2%; Moraga 1%.	Schedule time of traffic; coordinate with cities and counties.
• Noise and air quality	Equipment noise; dust during construction.	Mufflers on equipment. Dust suppression.
• Cultural resources	Two sites of potential archeological interest.	Exploratory site excavation and recording.
• Visual quality	Permanent change in appearance of site. Relocation of power transmission towers.	Consider esthetics in design of dam and other facilites.
• Public health and safety	Unquantifiably small risk of dam failure. Will reduce shortages caused by drought or outage.	Design dam to resist maximum credible earthquake.
• Growth inducement	Will provide capacity for development planned and permitted by cities and counties.	None required.

FIGURE 23. LOS VAQUEROS RESERVOIR (ELEV. 560')



LOS VAQUEROS RESERVOIR

Construction Access

- Pipeline, inlet-outlet tunnel, and pumping plant — from Highway 4 via Walnut Blvd. and Vasco Road.
- Dam — from Highway 4 via Walnut Blvd. and Vasco Road, and from I-580 freeway via Vasco Road.

Construction Time

- Pipeline in Vasco Road and Empire Road to the Mokelumne Aqueducts — a limited construction area progressing in stages along the pipeline route for an estimated total 20 months, with school schedules, holiday periods, and other community activites.
- Pumping plant — estimated 20 months for excavation, structure construction, and installation of piping, pumps, and electrical equipment.
- Pretreatment facilities — estimated 3 years for excavation, structure construction and installation of equipment.
- Reservoir inlet-outlet tunnel — estimated 12 months for excavating the tunnel and installing the pipe.
- Dam — estimated 3 years total time, including about 22 months for embankment and spillway construction.

Pipeline Alternatives

- Alternatives to the pipeline for connection of Los Vaqueros Reservoir to the water supply system include other pipeline alignments at an additional cost of $0 - 4 million.

LOS VAQUEROS RESERVOIR

POTENTIAL ENVIRONMENTAL EFFECTS		MITIGATION
• Land Use	2500 acres of cattle grazing land converted to body of water. Loss of 7 housing units.	Acquire watershed land; provide trail extensions.
• Hydrology and water quality	Potential erosion during construction. Beneficial effect on water supply availability. Improved flexibility in meeting flow requirements in lower Mokelumne River.	Use appropriate methods to control erosion.
•Geology and soils	No active faults pass through dam site. Exposure of facilities to seismic hazards.	Use appropriate technology to protect soils; design dam to resist maximum credible earthquake.
• Vegetation and wildlife	15 acres of riparian vegetation, 6 acres of pond and marsh habitat, and important wildlife habitats inundated.	Additional surveys; further purchase and or management of watershed.
•Traffic disruption	Pipeline construction.	Appropriate traffic controls and detours as needed; road improvement and relocation.
• Construction traffic	Temporary increase in traffic: Vasco Rd., Marsh Creek Rd., and Camino Diablo.	Schedule time of traffic; coordinate with cities and counties.
• Noise and air quality	Equipment noise; dust during construction.	Mufflers on equipment. Dust suppression.
• Cultural resources	17 prehistoric and 11 historic archaeological sites.	Exploratory site excavation; recording prior to completion of project.
• Visual quality	Permanent change in appearance of site.	Consider esthetics in design of dam and other facilites.
• Public health and safety	Unquantifiably small risk of dam failure. Will reduce shortages caused by drought or outage.	Design dam to resist maximum credible earthquake.
• Growth inducement	Will provide capacity for development planned and permitted by cities and counties.	None required.

SIGNIFICANT ISSUES

This section highlights the more significant concerns and questions from the public review of the Draft EIR and Revised Draft EIR, and the responses.

ALTERNATIVES

Comment: EBMUD staff has not fully considered the alternatives that could solve the security and shortage problems without construction of a new terminal reservoir or by the construction of a smaller reservoir.

Response: The arguments given in the comments have been reviewed and the conclusion is still that additional terminal storage, as part of a comprehensive program, is the best solution considering economic impacts on the District's customers, the potential hardships associated with strict rationing, the reasonable use of water in normal years but with improved efficiency and avoidance of waste, maintenance of a high quality water supply, and the potential environmental effects and mitigation measures. The range of alternatives is given in Table 11 and combinations of alternatives into composite program options are discussed on pages 22-24.

CAPACITY TO SERVE NEW DEVELOPMENT

Comment: A new terminal reservoir would only serve new development, particularly in the San Ramon Valley.

Response: The significant risk that an earthquake will damage and disrupt the Mokelumne Aqueduct pipelines in the Delta is a serious problem for both existing and new customers and is a principal factor in sizing the proposed additional terminal storage. The problem of drought shortages also applies to existing customers to the extent that the severity of rationing in time of drought would be improved by reducing the limit from 39 to 25 percent (see Figure 12 at a demand of 220 MGD). The allocation of cost shown in Figure 27 is based on the need for capacity, and shows existing customers assigned 43 percent and new customers 57 percent. New development is projected to occur throughout the District as shown by the increase in households and residential water use in Figures 10 and 11; it is not concentrated in the San Ramon Valley.

RESERVOIR SITE ISSUES

Comment: Buckhorn Reservoir would cause destruction of open space and unavoidable significant impacts.

Response: Buckhorn Reservoir would create an artificial lake on 1,124 acres of land, primarily used for cattle grazing and recreational hiking, in an open space settling of 46,000 acres in the East Bay hills. Open space is the absence of urban development. Buckhorn Reservoir would be part of the open space, just as the other five terminal reservoirs are, and to many people it would be a visual amenity.

The potential significant impacts described in the EIR are inundation of 34 acres of riparian vegetation and associated wetlands and loss of part of the spawning area of the steelhead rainbow trout that lives in Upper San Leandro Reservoir. No rare or endangered species have been found at the Buckhorn site. The impacts can be mitigated by enhancing riparian habitat and improving or creating spawning areas on Indian Creek, Redwood Creek, and/or San Leandro Creek, which are tributary to Upper San Leandro Reservoir. Indian Creek would be part of the acquisition of up to 4,800 acres of additional watershed land to prohibit future development, protect the watershed, enhance the open space, and provide additional hiking trails. The rainbow trout could also be introduced into the new reservoir.

Comment: Buckhorn Reservoir will cause significant climatic changes.

Response: Climatic changes are expected to be minor, and only in the immediate vicinity of the reservoir. The reservoir would have a moderating influence on temperature, about one degree warmer in the winter and one degree cooler in the summer. There would be no expected increase in the frequency of fog in nearby communities, and no impact on air quality.

Comment: The reservoior will impact recreation in the Upper San Leandro watershed area.

Response: The only recreation in and around the Buckhorn site is hiking on the established trail system. Existing trails would not be affected by the reservoir, except for one very short section that would be rerouted. The project would include expansion of the trail system. There is also the possibility of developing recreational improvements at Upper San Leandro Reservoir, with public access from Castro Valley. The preliminary plan includes boating and fishing, picnic sites, equestrian and bicycle trails, nature study, and additional hiking trails.

SEISMIC ISSUES

Comment: There appear to be active faults in the vicinity of the Buckhorn Reservoir site.

Response: The nearest active faults are the Hayward Fault about 3 miles west of the site and

the Calaveras Fault about 7 miles east of the site. The evidence of seismic epicenters east of the Hayward Fault have been attributed to the incline of that fault to the east, at a considerable depth. The closest the fault is to the reservoir site is where the fault is located at the ground surface (about 3 miles).

Comment: Failure of the dam in an earthquake is of concern, and would put tens of thousands of people below the dam at risk.

Response: With the application of available knowledge and technology, there is no reaason why an embankment dam capable of safely withstanding the effects of the maximum credible earthquake cannot be safely constructed at the Buckhorn site. This was the conclusion of a recent review by Professors H. Bolton Seed and Bruce Bolt (Unversity of California at Berkeley). When the great earthquake occurred on the San Andreas Fault in 1906, there were 33 dams in the Bay Area and 16 of those were within 5 miles or right on the fault. None of the dams suffered any significant damage. EBMUD's Chabot Dam, built in 1876, was one of the 33 dams.

The technical methodology for the seismic safety evaluation of a large dam is now well-developed, and with appropriate geological and seismological studies and analysis and design procedures a safe dam structure can be designed and constructed in areas of the highest seismicity. Throughout the Bay Area reservoirs exist above many urban areas, including EBMUD's five terminal reservoirs, but none of these is considered a risk to the communities below them.

The inundation scenario presented in the EIR is a very conservative analysis required by State law for all dams and does not consider the safety of the dam. The preliminary report prepared in 1980 for the U.S. Geological Survey on "Metropolitan San Francisco and Los Angeles Earthquake Loss Studies" discusses the potential losses for various dams for disaster planning purposes, and then goes on to say that such a dam failure is not a probable event.

Comment: Buckhorn Reservoir may induce earthquakes.

Response: A few cases are known around the world where filling of a reservoir behind a high dam has been followed at a later time by earthquakes near the reservoir. It is generally agreed among seismic experts that the size of such earthquakes is limited by the location of major faults under or very near the reservoir. In the case of Buckhorn, the natural seismicity of the nearby major Hayward and Calaveras Faults would govern the seismic design considerations, and any reservoir-induced seismicity would be small in comparison.

Comment: An earthquake or slide induced wave on Buckhorn Reservoir would splash over the Brown Road saddle on the north side and flood Moraga.

Response: The "freeboard" or difference in elevation between the maximum water surface and the saddle is 15 feet, the same as between the water surface and the crest of the dam. The maximum expected wave due to an earthquake is less than two feet high. The significant slide areas would all be below the water surface and thus would not present a risk of wave action.

TRUCK ROUTE IN CASTRO VALLEY

Comment: Truck traffic on Redwood Road is a concern; there must be alternative routes. Cull Canyon is not an viable alternative.

Response: Only 5 percent of the embankment materials for Buckhorn Dam would have to be hauled into the project site from the Livermore Valley, including filter material, rip-rap, and rock for dikes. The major part of the embankment would be from borrow areas within the reservoir. From the I-580 freeway, the proposed haul route would follow Castro Valley Boulevard, Redwood Road, and Miller Road as shown in Figure 24.

The EIR describes limiting the hours of trucking to between 8:00 a.m. and 2:00 p.m. when schools are in session, but this would increase the number of trucks per hour during the shorter hauling time.

The only alternative haul route that appears to be feasible would be from I-580 to Crow Canyon Road, Cull Canyon Road, and a new haul road constructed over the ridge between Cull Canyon and Miller Road (see Figure 24). Cull Canyon Road is very narrow in places and its pavement is not designed for the truck loading that would be imposed. This alternative would increase the project cost by about $5 million to repair damage to Cull Canyon Road and to build a bridge across Cull Creek and the haul road over the ridge.

A possibility would be to use the Redwood Road route for loaded trucks going into the project site, and the Cull Canyon route for returning empties. This would spread the traffic impact and reduce the potential damage to the pavement on Cull Canyon Road.

PIPELINE THROUGH MORAGA

Comment: Pipeline construction in the streets of Moraga is a concern; there must be alternatives.

Response: A number of alternatives pipeline routes and pumping plant locations have been

investigated. Additional studies indicate that the pumping plant can be relocated from the site at St. Mary's College to EBMUD property closer to Buckhorn Reservoir, and the section of existing Moraga Aqueduct along St. Mary's Road and through Moraga Commons can be utilized. Because that section of pipe is smaller diameter than the proposed Buckhorn Aqueduct, its use would require an even larger pipe from Moraga Road to the reservoir to balance the hydraulics. The new alternatives are shown in Figures 25 and 26. Alternative D3 would cause the smallest increase in project cost and would have the least pipeline construction in streets, avoiding St. Mary's Road and Camino Pablo. The added cost of larger pipe and additional tunneling would be more than the cost savings of a shorter pipeline, and the net increase in project cost would be $5 million.

FIGURE 24. TRUCK ROUTES FOR BUCKHORN RESERVOIR

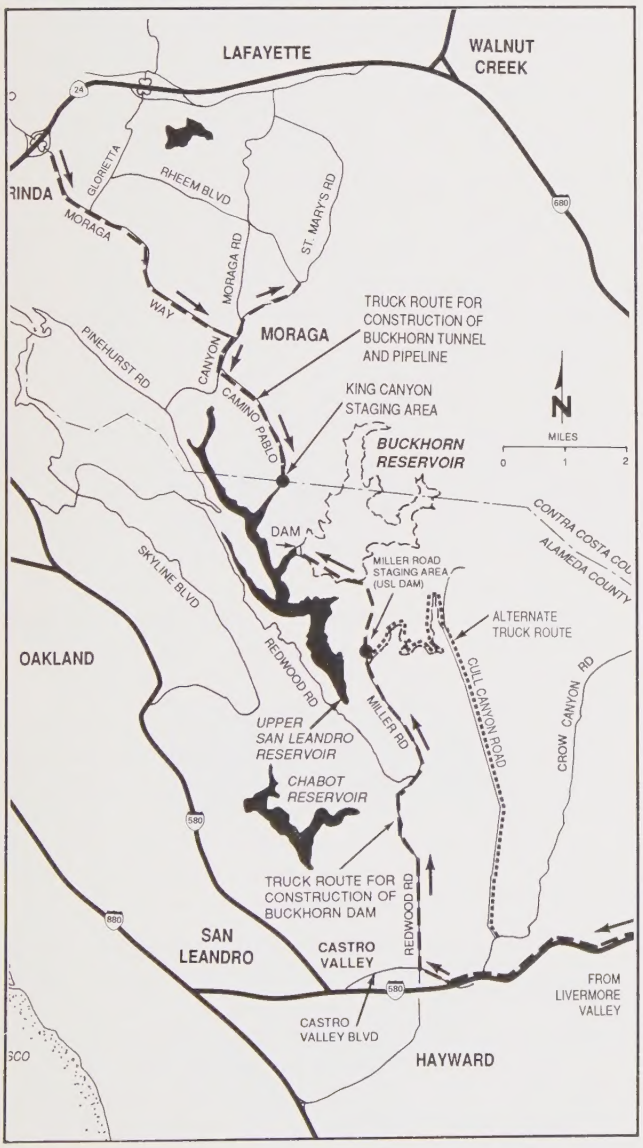


FIGURE 25. BUCKHORN PIPELINE ALTERNATIVES D1 AND D2

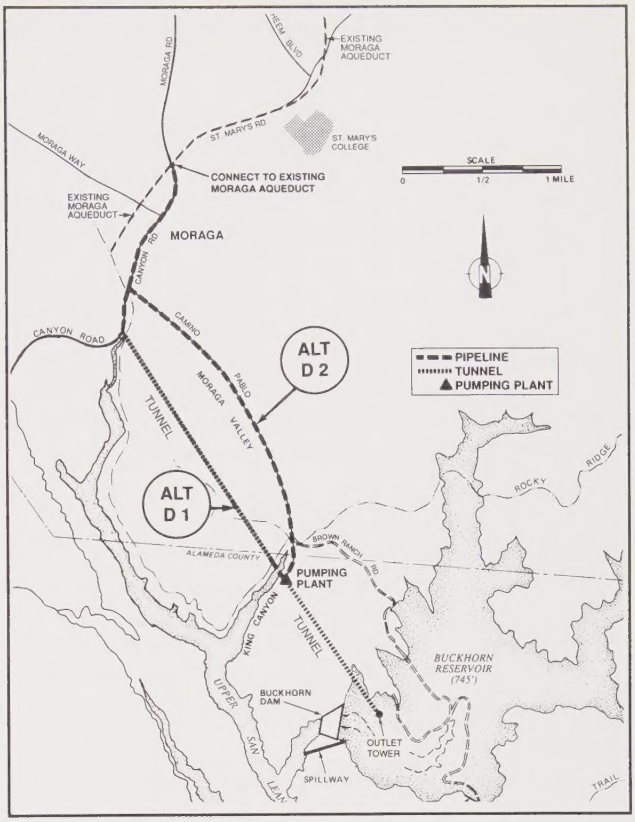
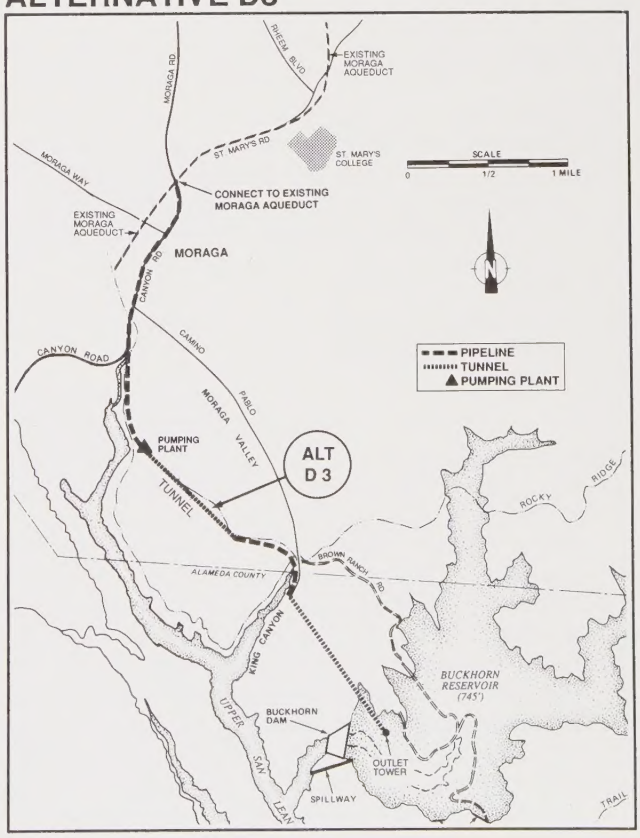


FIGURE 26. BUCKHORN PIPELINE ALTERNATIVE D3



CONCLUSIONS

The following discussion summarizes the staff conclusions.

Security

1. A 13-month outage of the Mokelumne supply due to a major earthquake damaging the aqueducts across the Delta is a significant risk with a frequency estimated to be more than once in 100 years.

2. Basic improvements in the Delta, including continuation of the levee repair program and preliminary engineering for aqueduct replacement, would help prepare for a disaster; however, they would not protect against severe rationing during a 13-month outage.

3. Water banking by constructing additional terminal storage would provide for EBMUD's security needs by being available to deliver water to the District's customers during an outage of the Mokelumne supply. With a projected demand of 270 MGD in 2020 and a reduced limit of 25 percent on rationing, 145,000 acre-feet would be needed.

Shortage

4. Water conservation and water reclamation are an important part of water supply management. Additional measures and reclamation projects are feasible.

5. The increased efficiency of water use resulting from water conservation would not significantly reduce shortages in dry periods.

6. Water banking in normal and wet years by constructing additional terminal storage could reduce shortages in dry periods and limit restrictions to 25 percent during a drought. With a projected demand of 270 MGD in 2020, 95,000 acre-feet would be needed. This quantity is less than that needed for security (see above); therefore, the capacity required for security would govern.

Limit on Rationing

7. The District's Water Supply Availability and Deficiency Policy was designed to meet a drought like 1976-77 with no greater rationing hardship than experienced in 1977. In recent years, the increased water use efficiency means that the 39 percent reduction level will have a greater impact. To be consistent with the District's objectives, this percentage should be reduced to 35 percent, and since no new storage has been constructed since the 1960's, and existing customers are at greater risk than the District has historically experienced, the percentage should be significantly reduced to 25 percent for both security and shortage.

Terminal Storage

8. Buckhorn is the best reservoir site from the standpoint of location, operation, water quality, watershed ownership and protection, cost, potential environmental effects, and opportunities for mitigation. It must be evaluated by studying all of the issues addressed in this report. The District will weigh the negative effects against the long-term benefits of water banking and quality protection.

9. These conclusions assume that terminal storage is justified by either the security or shortage need, but not both at the same time. A significant argument could be made that a moderate drought when combined with a Delta failure of lower magnitude could result in the same or greater impact than one or the other risks individually. The District and other utilities have traditionally planned conservatively when making capital investments since the incremental costs of a major investment is small compared to its benefits.

10. The selection of Buckhorn Reservoir at this early stage in the project should not close off EBMUD's cooperative activities with CCWD regarding Los Vaqueros Reservoir. Until the regulatory approval process is completed for Buckhorn, Los Vaqueros should continue to be an alternative. The estimated cost of participating with CCWD in its ongoing preliminary engineering and environmental review process is estimated at $300,000.

Safety and Health

11. Monitoring and controlling activities affecting the Mokelumne and terminal reservoir watersheds has been effective in helping to provide high quality water.

12. The purchase of additional watershed lands to the ridgelines around the existing and any proposed terminal reservoir would help assure that the high quality of stored water can be maintained into the future, and have other significant public benefits.

13. The treatment improvement program will assure that water quality will meet new drinking water standards and water treatment operations will be improved; continued studies of advanced treatment technologies may decrease the use of chemicals and further improve water quality.

TABLE 15. COMPOSITE PROGRAM (OPTION 4)

WATER BANKING

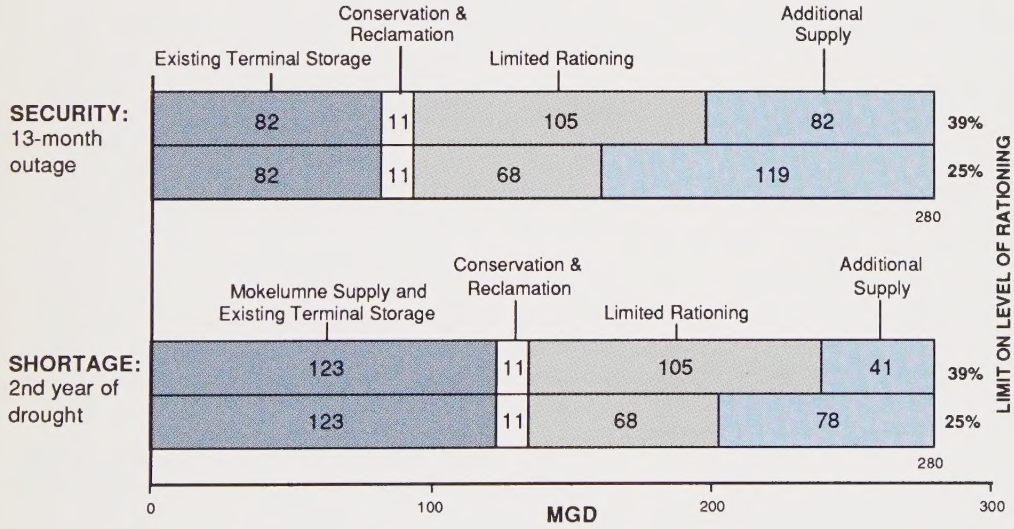
Emphasis on additional terminal storage with feasible conservation and reclamation.

● PROPOSED ALTERNATIVE

○ PILOT PROGRAM OR STUDY

		REDUCE FUTURE DEMAND							PROVIDE SUPPLY DURING OUTAGE OR SHORTAGE										
		WATER CONSERVATION					WATER RECLAMATION			NEW PIPELINE ACROSS THE DELTA		WATER BANKING			INTERTIES WITH OTHER AGENCIES				USE OF DELTA WATER		OTHER SOURCE		
	1. Do Nothing	2.1 Existing Program	2.2 Landscape and Water Management	2.3 Ultra Low Flow Toilets and Showers	2.4 Water Saving Technology	2.5 Landscape Rebate Program	3.1 Chevron and Alameda Projects	3.2 San Ramon Valley Irrigation	4. Levee Improvements in the Delta	5.1 Limited Capacity Pipeline	5.2 Full Capacity Pipelines	6.1 Pinole Reservoir	6.2 Buckhorn Reservoir	6.3 Los Vaqueros Reservoir	7.1 Hayward Treated Water	7.2 Contra Costa WD Treated Water	7.3 Hetch Hetchy Untreated Water	7.4 Alameda Co. Zone 7 Treated Water	8.1 No Pretreatment	8.2 With Pretreatment	9.1 Exchange with Woodbridge	9.2 Purchase Mokelumne Water	10. Watershed Enhancement
ALTERNATIVES INCLUDED IN OPTION	—	●	●	○	○	○	●	—	●	—	—	—	●	—	○	○	○	○	—	—	—	○	●
SECURITY — WATER SAVINGS/SUPPLY (MGD)		6					5		—			82—119											—
SHORTAGE — WATER SAVINGS/SUPPLY (MGD)		6					5		—			41—78											—
MEETS WATER QUALITY OBJECTIVES?		YES					YES		Y			YES											Y
COST ($ MILLION)		0.8 PER YEAR					17		8			160											20

RESULTING SUPPLY CONDITIONS IN 2020



ESTIMATED PROGRAM COST

	$ MILLION
Total Capital Cost:	205
Present Worth of Annual Conservation Costs:	9
SUBTOTAL:	214
Present Worth of O & M Costs:	71
Present Worth of Future Pipe Replacement:	85
TOTAL:	**370**

REMARKS:
- For security, storage would be:
  100,000 acre-feet for 39% limit on rationing — would provide 82 MGD additional supply.
  145,000 acre-feet for 25% limit on rationing — would provide 119 MGD additional supply
- Variations of this composite program option would include the Los Vaqueros Reservoir site (see Table 12).

ACKNOWLEDGEMENT

The reports and this summary were prepared by EBMUD staff with the assistance of the consultants listed below.

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PUBLIC HEARINGS

WATER SUPPLY MANAGEMENT PROGRAM

TUESDAY, MARCH 7, 1989

1:30 PM

EBMUD ADMINISTRATION CENTER
2130 ADELINE STREET (AT WEST GRAND)
OAKLAND, CA

7:00 PM

OAKLAND CONVENTION CENTER
EAST EXHIBIT HALL
550 - 10TH STREET (NEAR BROADWAY)
OAKLAND, CA

For more information please call the EBMUD Public Affairs Office at (415) 835-3000, extension 610.

A PUBLIC PROCESS

EBMUD must consider the impact of its proposed program on the people and area it serves. District staff produced a series of reports for public review, and the comments received each time were considered in preparation of the next draft.

In February 1987, comments were solicited on a discussion paper describing the issues and the program being developed. The Draft EIR and Technical Report were produced in April 1988 for a 45-day review period, with a public meeting in Oakland on May 18 and a public hearing in Walnut Creek on May 25. A Revised Draft EIR and Technical Report were produced in September 1988 for an extended review period of more than two months, with public hearings in Oakland and Walnut Creek on November 14 and 16.

In addition, EBMUD staff has made a concerted effort over the past two years to meet with and brief local government and organizations on the key issues and needs and to respond to different viewpoints about the proposed program.

The draft of the Final EIR and Technical Report have been submitted to the Board of Directors for its consideration. Before it adopts any projects or actions for the Water Supply Management Program, the Board will conduct public hearings.

Copies of the draft of the Final EIR and Technical Report are available from the EBMUD Office of Planning, 2127 Adeline Street, Oakland, CA 94623, telephone number (415) 835-3000, ext. 557.

Public hearings are part of the public process.

EAST BAY MUNICIPAL UTILITY DISTRICT
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